Process Simulation of MEG Regeneration Unit

by

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Dissertation submitted in partial fulfillment of

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

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Approved by,

....

(Dr Nejatollah Rahmanian)

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

SEPTEMBER 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecificied sources or persons.

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NUR NATASHA BINTI KAMAL

ABSTRACT

Hydrate formation in natural gas pipelines can be inhibited by passing thorough Monoethylene Glycol (MEG) in transportation pipelines. Absences of MEG in transportation pipelines will reduce the hydrate formation and at the same time will increase the quality of natural gas. MEG is most favorable because it is reusable, increase corrosion protection, and non flammable. Furthermore, MEG has high absorption efficiency, easy and economic regeneration. However, since MEG can be reused, all salt contains has to be removed before recirculating MEG in subsea pipelines. This is to avoid blockage of pipelines and to sustain the quality of MEG in hydrate prevention. Thus, regeneration unit is vital in order to remove all impurities in rich MEG and to avoid the saturation of contaminants in MEG. Current regeneration plants will produce high purity which is up to 99% weight of lean MEG for the subsea pipelines. However, this project will cover on producing 70% weight of lean MEG as final product.

Furthermore, for this regeneration of MEG, reboiled absorber is chosen instead of distillation column due to several reason. In regeneration unit, simply boiling of rich MEG will result all contaminants consist of water formation salt, corrosion scale and non-soluble salt to be deposited at the bottom of regeneration unit. As consequence, regeneration unit will come to the extend it has to be shut down often due to maintenance of column. In order to solve this problem, reclamation unit is being installed together with regeneration unit as to remove all salts contains. Reclamation unit consists of two types, which are full reclamation and slip stream reclamation. Both will be discussed further along this project. As for simulation of regeneration unit of MEG, Aspen HYSYS 2006 is being used instead of ICON, and Peng Robinson fluid package is being chosen with several concrete reason. In addition, this simulation will come with some graphs as to observe effect of changes of any parameters available.

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In the name of Allah, the most gratitude and most merciful

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LIST OF ABBREVIATIONS

MEG	- Monoethylene Glycol
P&ID	- Piping and Instrumentation Diagram
PFD	- Process Flow Diagram
PLC	- Programmable Logic Controller
$CaCO_3$	- Calcium Carbonate
$CaCl_2$	- Calcium Chloride
$Na2CO_3$	- Sodium Carbonate

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CHAPTER 1
PROJECT BACKGROUND

1.1 Executive Summary

Simulation models have been extensively used since 1980s [1]. Simulation is the imitation of some real thing, state of affairs or process that can be validated before being transformed or constructed in reality. Furthermore, parameters that represent real data in the plant can be adjusted to simulate actual plant performance and this model also can be used to evaluate alternative processes.

Figure 1 below shows the overall view for gas plant processing. Basically, natural gas coming from well is transported through double pipe of 32' diameter to the slug catcher with a distance of 100 miles of pipeline. The natural gas from pipeline will be distribute in two path which is gas conditioning and glycol/condensate separation. As in condensate separation, the condensate must be stabilised for the safe storage and transportation. In other way, for the glycol separation, it will be sent to MEG regeneration unit. The present of MEG in this gas plant processing is to inhibit the hydrate formation in production pipeline.

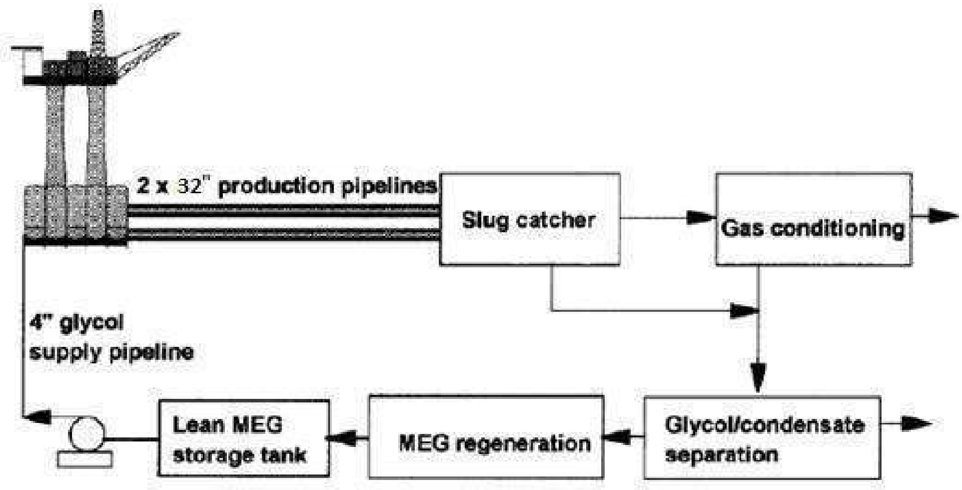

Figure 1: Overall View for Hydrate Prevention Process [2]

Simulation of MEG regeneration unit is crucial in order to evaluate the performance of process plant and alternative of regeneration processes since this technology has not been leveraged extensively enough in the process plant. There are several ways of regeneration process. Regeneration by traditional distillation will achieve a high concentration of MEG in regenerated glycol, which will achieve about 1% of water content at the final product of regeneration. They consist of usage of stripping gas with or without extra column, Coldfinger, Drizo and the Read Cycle [3].

As for this paper, we will be discussing on the development of a simulation process of MEG that will produce 70% glycol content and 30% water content. The final product of glycol regeneration is said can reduce the inhibitor costs for natural gas in pipelines. Basically, for the hydrate formation prevention, 90% of MEG is injected in the subsea pipelines. Nevertheless the long distance between the lean MEG storage and subsea well make 90% of MEG is a waste since the inhibitor has to be transported with more energy as the inhibitor has high volatility. Thus, an alternative to reduce cost for the prevention of hydrate formation is through injection of less volatile inhibitor.

The need for regeneration unit of Monoethylene Glycol (MEG) is to remove the water condensed in the pipelines, dissolve hydrocarbon and corrosion metal from closed loop of MEG. Steps have to be taken in order to prevent the plugging in the pipeline and at the same time to reduce the capital cost of regeneration of MEG. In addition, regeneration of MEG seems inadequate as a step to prevent the plugging of salt and corrosion metal, thus reclamation unit will be discussed in this paper. Verification of simulation also will be included in this project.

Simulation of MEG regeneration units will be designed in HYSYS software since HYSYS is the preferable software being used in process plant. Furthermore, HYSYS is suitable software to be used to simulate any process that is existed or will be developed later.

1.2 Introduction

Simulation is a design of a process in which particular set of conditions is created artificially in order to study or experience something that could exist in reality. In other way, simulation is the imitation of some real thing, state of affairs or process.

Process simulation is a model-based design representing real plant before being constructed. This simulation will help engineers validate process design and the control strategies to be implemented by testing them before being engineered. Furthermore, process simulation software allows chemical and physical properties of pure components and mixtures of reaction and mathematical models, in succession can be calculated using simulation software. Moreover, process simulation will describe real process through presentation of piping and instrumentation diagram and processes in flow diagrams where unit operations are located and connected by product or educts streams. Regeneration of monoethylene glycol (MEG) is crucial in order to achieve high concentration of MEG to prevent hydrate formation in pipelines. In addition, simulation of regeneration of MEG is important to evaluate alternative regeneration processes. Thorough simulation, engineer might have opportunities to model a real life situation in a computer so that it can be studied to see how the system really works.

There are software being used to simulate the materials and energy balances of chemical processing plants such as ChemCAD, HYSYS and Aspen Plus [3]. For this project, we will look more on HYSYS software. Development of HYSYS model starting from the unit's P&IDs PFD and PLC configurations. Different cases for new plant, which we can validate the process and control strategies to be used before the plant is construct. Thorough simulation, engineers will be able to identify and withdraw some processes problems related to the plant's start-up, operation and shutdown.

Regeneration of MEG for this paper is being specified to obtain 70% of glycol concentration at the end of the process. For this purpose, a new alternative of regeneration will be developed throughout this paper. Feed for this paper is taken from South Pars Gas Field (Assaluyeh, Iran) that has been operated since 2009.

Table 1: Main Composition for Feed Stock of Regeneration of MEG

Component	Main feed from Slug Catcher/ HP Separator
Methane	0.000800
Ethane	0.000189
Propane	0.000103
I-Butane	0.000001
n-Butane	0.000002
I-Pentane	0.000000
n-Pentane	0.000000
Mcyclopentane	0.000000
Benzene	0.000010
n-Hexane	0.000000
Cyclohexane	0.000000
Mcyclohexane	0.000000
Toluene	0.000000
n-Heptane	0.000000
n-Octane	0.000000
p-Xylene	0.000001
n-Nonane	0.000000
Cumene	0.000001
n-Decane	0.000000
C11+	0.000000
Nitrogen	0.000007
Carbon Dioxide	0.000635
Hydrogen Sulphide	0.001145
Water	0.826214
M-Mercaptan	0.000008
E-Mercaptan	0.000011
COS	0.000000
nPMercaptan	0.000001
nBMercaptan	0.000001
1Pentanthiol	0.000001
MEG	0.170682

Table 2 : Properties of Feed Stock

Properties	
Normal Flow, (kmol/hr)	1308
Normal flow, (kg/hr)	33467
Heat flow, (kW)	1315
Molecular weight, (kg/mol)	25.6
Pressure, (barg)	6.0
Temperature, (^{o}C)	41.3

1.3 Problem Statement

The problem statement for this simulation of regeneration of MEG is the recent technology of regenerating MEG consumes high capital cost since the purity of final MEG is up to 99% of glycol content.

1.4 Objective

The goal of a process simulation is to find optimal conditions for an examined process, which to obtain lean MEG of 70% wt of glycol content and 30% wt of water and at the same time to find an alternative on how to minimize the risk of production changes or the ramp-up of new productivity lines. By having simulation of process, engineers will be able to predict the performance of an existing or planned system and to compare alternative solutions for a particular design problem.

1.5 Scope of Study

This simulation of MEG regeneration units' scope of study is related to the process simulation by using HYSYS software. As time goes by, the author will elaborate, share more on how to simulate MEG regeneration units using HYSYS software by doing some researches and consult any arise matter with responsible supervisor. Other than that, author will also explain deeply on monoethylene glycol (MEG) and reason MEG has been chosen as inhibitor for hydrate prevention in natural gas. Moreover, the details of process plant also will be discussed in this proposal, such as process flow diagram, and the crucial problems regarding the salt content and corrosion metal from the pipelines.

1.6 Relevancy and Feasibility of The Project

Today, simulation of MEG regeneration units plays a big role in oil and gas field. In order to protect and conserve the quality of natural gas, hydrate prevention through the deepwater transport pipelines is crucial to avoid the corrosion and blockage of pipelines. The inhibitor used in this system usually is being reused over and over, and regenerated since the selected inhibitor has the value of being reused [4].

However, the rich MEG is being boiled under boiling point of water in order to vaporize the water content absorbed in the natural gas pipeline. Repetition of this process will give disadvantage to MEG since it will be saturated after being boiled for several times. This will bring disadvantages to the extend process plant will shut down due to the failure. Thus regeneration of MEG is important to avoid this circumstance. Since regeneration of MEG is rarely found, it is important to come with the invention of producing regeneration units of MEG. For this important decision making, engineers must come with the verified result as evidence on how well their regeneration units will work. At this point, simulation of MEG regeneration units is important for the engineers since they can verify the work ability of their process plant without consuming more time on the calculation of involved parameters. Other than that, they also can verify the details of process plant successfully.

Moreover, regeneration of 70% glycol content will give big advantage in gas field industry since the cost for consuming glycol is being reduced by producing low concentration of MEG. This has been implemented in South Pars Gas Field developed by PETRONAS [5]. Basically, the more concentrated mixture will give significant output. However, in hydrate prevention of natural gas in pipelines, having less than 80% of glycol is sufficient for preventing the hydrate to form in natural gas pipelines.

CHAPTER 2

2.1 Literature Review

Natural gas pipelines in Kazakhstan were found to be clogged with an ice-like substance in 1929 [6]. It had been observed that pipelines were often clogged this way in winter, when the water vapor in the natural gas was assumed to condense and freeze, so it was general practice to remove water in natural gas as to deliver to the onshore. Natural gas transmission pipelines are being laid along the floor of deepwater sea. Most of these pipelines run for hundreds of kilometers at water depths in excess of 2000 meters [7]. At this occurence, pipelines under the sea are being exposed to low temperature and high external pressure. Salt water and corrosion also attack the transport pipelines. At this water depth, small pipelines penetrations due to corrosion can provide a path for water to enter the pipelines due to high external pressure. The consequence of this phenomenon will lead to hydrate formation [8]. Hydrates will form and the resulting hydrate will block gas flow in the pipelines. Hydrates are formed when the natural gas coming thorough pipelines are in contact with the high external pressure and low temperature along the transport pipelines [9]. These hydrates act as non-flowing crystalline solids that are denser than typical fluids hydrocarbon and form large solid plugs that can block pipelines and disrupt production. Moreover, hydrates formation will come to the extent that they can cause pipelines to burst. It has been said that hydrates have been a longstanding problem in the gas industry (Hammerschmidt's 1934 paper "Formation of Gas Hydrates in Natural Gas Transmission Lines").

The hydration of natural gas must be minimized since natural gas is the premium fuel for this decade. Natural gas in coming to market through the deep water transport pipelines should not contain more water content as to prevent hydrate from forming. Most oil and gas company realized that hydrate inhibitor is crucial to prevent of line plugging due to formation of hydrates. Furthermore, it is also a step to prevent the reduction of line capacity because of formation of free water and to minimize or eliminate corrosion in the transport pipeline. Removing of water from natural gas will give significant value since there is no free water with resulting hydrates will form in the pipelines. Moreover, this will increase the line of gas carrying capacity since free water in the pipelines occupies volume of the stream [9]. The third reason is also to reduce corrosion [10]. Any liquid water in the presence of any acid in the stream will form even more corrosion of pipelines, thus step of removing water content from natural gas will reduces the corrosion of pipelines. Monoethylene glycol is most desirable kinetic inhibitor because it is has high absorption efficiency, easy and economic regeneration, non-corrosive and non- toxic [12]. In addition, it has no operational problems when used in high concentration and not contaminate by interaction of acid gas. Glycol with act as the principal agent, has a chemical affinity for water which means it has the ability of stealing water from the natural gas, thus prevent the hydrate formation..

A selection of either monoethylene glycol (MEG) or other remaining glycol for deepwater hydrate inhibitor involves comparison of many factors including capital and operating cost. MEG is the most favorable for the operator as they were dealing with the MEG mostly [4]. MEG is mixed in with natural gas before being transport to reduce the freezing point in the pipelines, to prevent blockage due to hydrates and to achieve increased corrosion protection [10]. This MEG will steal water content from the natural gas by absorption process. Furthermore, MEG that simultaneously act as corrosion protective itself can reduce the capital cost and operational cost regards to corrosion inhibitors for the pipeline. MEG is non-flammable, having flash point of 111^{o}C and thus give less risk of handling that methanol.

Since MEG can be reused, the decision to install a regeneration system is driven as an economic trade-off between capital expenditures versus operating expenses. MEG that playing role in closed loop pipelines will gradually become contaminated within the operating time. Impurities consist of water, salt and corrosion metals from natural gas must be treated and removed the unnecessary element in a controlled manner, regular replacement or continuous make up in order to deflect corrosion in regeneration system. The regeneration of MEG is essential since products from the natural gas pipelines are the main causes of these problems. Simply boiling of rich MEG in regeneration will result in all of other pollutants to be accumulated in the MEG. Thus, contaminants will become saturated with MEG and precipitation will commence. As a consequence, this will cause the operational problems and the need for clean out of the system, which will result in shutdown of process plant. Regeneration of MEG, coming with the reclamation will successfully remove the salt content and any other contaminants and this will give significant value for natural gas.

The main concern in the simulation is the interaction between water and glycol. In process simulation, the individual components in the process plant must be described by a simulation element. Simulation models have been extensively used in the downstream refining and chemical industry since the 1980s [1]. Simulation helps engineers to predict the performance of an existing or planned system and to compare alternatives solutions for a particular design problem. By having simulation, engineers will undoubtedly have process modeling requirements that are not all handled within a single package. The typical solution is to generate results in one package, then transfer necessary information into a second package. Without simulation, this is possibly will take a long time as repetation of calculation from beginning need to be performed. Simulation will help engineers to generate value in no time, since all thermodynamic work is performed within a common framework, elimination the tedious trial and error process.

2.1.1 Stripping Gas to Extra Stripping Column

Simulation of MEG regeneration units by using extra stripping column will reduce amount of stripping gas needed to achieve certain amount of water and MEG contents in the final product. Addition of a new recycle control block is needed to control the stripping gas flow from the extra stripping column [11] that is added for the efficient use of the stripping gas. Moreover, by applying this technology, engineers will have the possibility to simulate the regeneration column and stripping column as one column.

2.1.2 Read Cycle

A read cycle principle is the matter of recycling the hydrocarbon gases from the regeneration column as stripping gases [11]. The gas produced from the top of distillation column will be cooled to desire temperature and water will condense and hydrocarbon are pressurized with a blower and used as stripping gas in the next cycle of regeneration of MEG. The advantage of the read cycle is that there is no need for an additional extra stripping column. Moreover, by implementing Read Cycle, there will be not much simulation complexity to the calculations.

2.1.3 DRIZO

In DRIZO, a stripping gas medium used in the regeneration unit is recovered as a liquid after the regeneration column [11]. The liquid usually is separated in three phase separator and is recycled to the regeneration columns. When applyling DRIZO process, only a pump is necessary to recirculation the stripping gas. However, introduction of a stripping medium introduces new complications in the simulation. Furthermore, in the DRIZO process, gas circulation is needed in order to purge the gas.

2.1.4 COLDFINGER

The principle of the Coldfinger process is that the partly regenerated MEG will be further concentrated in a two phase tank with a cold spot and a condense collector in the gas phase [11]. This further concentrated process will result in reduced water pressure in the tank and more water will be evaporated from the MEG. The main advantage of this Coldfinger process is that, it produces more concentrated glycol without having to add an extra stripping column. By using Coldfinger process, high concentrated of glycol will be produced with a very simple unit. However, the Coldfinger process will consume an extra cost since extra equipment and the extra heat added to compensate for the cooling.

2.1.5 Process Simulation of MEG Regeneration Unit

Process of regeneration and reclamation of MEG is another alternative on how to regenerate MEG. Rich MEG will be heated in distillation column in order to remove amount of water. This process will reduce huge amount of water from the MEG. However, salt and hydrocarbon content are not removed by this process, thus reclamation process of MEG is implement in order to remove all the salt content by evaporating the lean glycol coming out from distillation column and degradation of MEG usually occur at this regeneration and reclamation condition.

Thus, for this simulation of MEG regeneration unit, the three traditional method will not be used since the final product is far for the targeted value. A new regeneration unit will be developed by taking the examples of regeneration as a reference in regeneration of MEG unit.

Table 3: Properties of MEG [12]

Product Identification	**Details**
Formula	$C_2H_6O_2$
Molar mass, (g/mol)	62.07
Toxicity, (mg/kg)	Oral rat LD50; 4700
Synonyms	1,2-Ehtanediol; Glycol; MEG; 1,2-Dihydroxyethane; 1,2-Ethanndiol; 2-Hydroxyethanol; Athylenglykol (German)
Physical state	Clear liquid
Melting point, (^oC)	-13
Boiling point, (^oC)	197-198
Specific gravity	1.115-1.1156
Solubility in water	Miscible
Stability	Stable under ordinary conditions

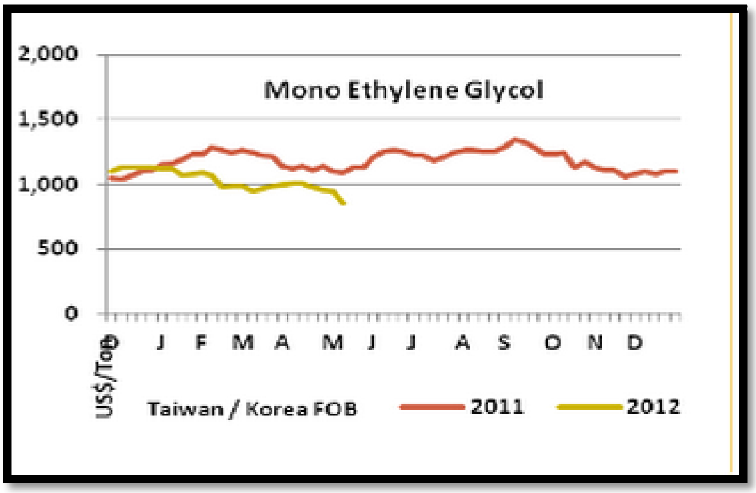

Figure 2: Spot Market for MEG [13]

Figure 2 shows control chart above showing the behavior of MEG spot market in Asian for duration of 2011 until March of 2012 [13]. Price of MEG is said to be up and down due to some reason such as the effect of natural disaster, the new start-up at polyester plant and the increasing of port inventories. From the control chart above, the price of 99% purity of MEG is said to be around 900 US$/tonne – 1500 US$/tonne.

However, deals were mostly traded at average of 1250 US$/tonne on 2011. In 2012, price of MEG has declined to below than 1000 US$/tonne [13]. Basically, MEG is being used in gas field industry as a liquid desiccant for the kinetic inhibitor of natural gas in pipelines, and is being recycled for reuse in pipelines. However, 99% of MEG content in MEG will cost very high value per tonne for hydrate prevention of natural gas. Thus, for this project, simulation of MEG containing 70% of pure glycol and 30 % of water will be developed in order to find an alternative to reduce the capital cost since there will be a huge different in price per tonne for different purity of MEG.

In order to produce desired product, some changes has to be made to regeneration unit that produce 99% of glycol content. Similar to other regeneration unit, for this process, the equipment needed are the same with the basis of regeneration unit such as flash vessel, separator and reboiler absorber. However, new operating condition has to be found in order to produce the desired product.

Basically, the feed stock coming from slug catcher/HP separator has to be heated to certain temperature for the regeneration to proceed since feed stock temperature given is quite low, which is 41.3^{o}C.

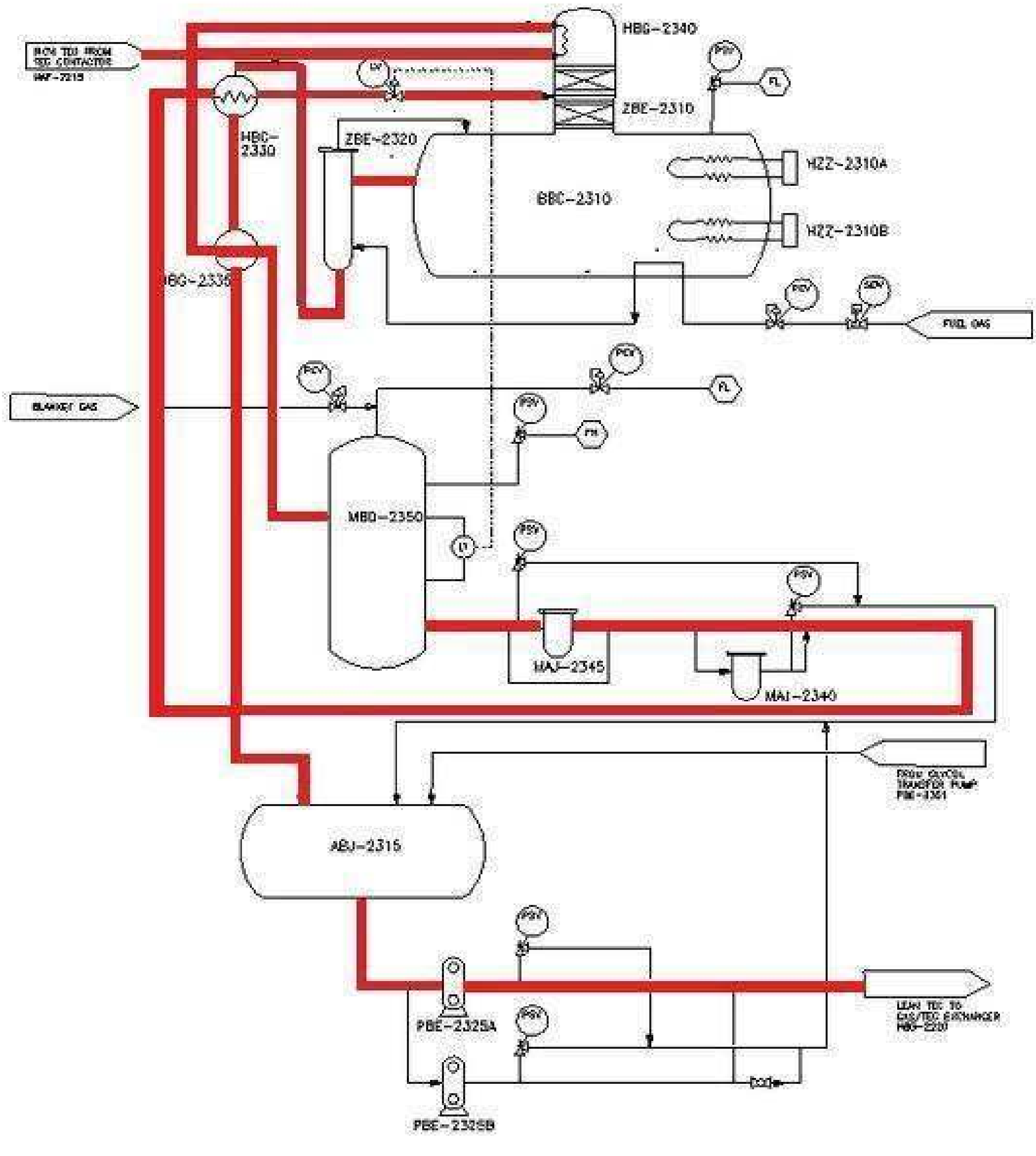

Figure 3: PFD for MEG Dehydration [14]

Figure 3 shows Process Flow Diagram (PFD) generated by Agip-Iran (B.V) [14]. This PFD will be taken as references for this paper in developing regeneration of MEG contains 70% of glycol contain. From this figure, rich glycol is being passed to flash drum/vessel where most of hydrocarbon will be removed. After coming out from the flash drum, two filter units are being added in order to remove solid particles contain in lean MEG. Then, lean MEG is passes through heat exchanger where lean MEG is being pre-heated before entering the distillation column. Re-concentrated glycol is being used as heating agent. From figure, it observed that re-concentrated glycol is passes to the heat exchanger where lean glycol has to pass to reach to distillation column.

For this simulation of MEG regeneration units, HYSYS software will be used to model the system. First step to start using HYSYS is by conveying the process flow diagram into a dynamic process diagram. HYSYS is selected among simulation software is because it is easier to deal with the HYSYS compared to ICON. With HYSYS, engineer can create rigorous steady state and dynamic model for plant design, performance monitoring, troubleshooting, operational improvement and asset management's [15]. Simulation of MEG regeneration units will give most benefits to the engineer with the idea of inventing new regeneration for MEG. This is because they will have more time to investigate further about the regeneration system without spending time on calculation for the parameter involved in system. Furthermore, this simulation also will help engineer to verify their ideas and evaluate alternative regeneration processes. Thorough simulation, engineers might have opportunities to model a real life situation on a computer so that it can be studied to see how the system really works.

CHAPTER 3

3.1 Methodology

As for the very first step in completing this task, the author will have to do some researches on simulation topics to get an overview for this whole problem. Regeneration of MEG is important since capital cost will be reduced in effort of preventing formation of hydrate. However, it is found that high purity of MEG for the effort will consume more energy and regeneration will be costly. Thus, the other alternative is to produce MEG of 70% purity for the process. In order to proceed with the simulation, process route has to be selected among the regeneration process found in literature review.

Planning is the most important step in accomplish a task. For this matter, the author will have to plan well on what to be done first. Planning is an important steps since each act should be done in a right manner to make task easy to be accomplished. Simulation of regeneration process will require some parameters such as operating temperature, pressure, flow rate, mass balance and etc.

3.1.1 Equation of state

In simulation of any process, after defining the component to be used, we have to select the fluid packages or thermodynamic method for the purpose of calculating the quantities such as enthalpy, entropy, density, molar flow and other phase equilibria values and other transport properties. In simulation, the most crucial decision to be made is which thermodynamic method should be selected that is appropriate with the given mixture. Wrong decision will lead to physically meaningless result and far from targeted value. Model for process simulation of MEG has been developed in HYSYS by using Peng Robinson equation of state.

"Models for all the glycol regeneration processes have been developed in the process simulation program HYSYS with the Peng Robinson equation of state. The models......." (Erik L. , Tyvard E., 2002) [11]

However, there is a conflict of choosing Peng Robinson instead of Glycol Package that has been developed by HYSYS recently. Since the idea of this simulation is regeneration of MEG, the author decided not to use Glycol Package for several concrete reasons. Twu-Sim-Tassone (TST) is the modification of equation of state which has been modeled for hydrocarbon systems-non ideal systems (used for glycol package) . In Fluid Phase Equilibria handbook, there is stated that advanced equation of state method for modeling tri-ethylene glycol (TEG)- water for glycol gas dehydration. According to Fluid Phase Equilibria handbook;

"The TST cubic equation of state has been developed successfully to represent the TEG-water binary, which is an industrial important system for modeling TEG gas dehydration. This work is an improvement over the empirical hyperbolic equation of Parrish et al." (Twu C. H., Tassone V., Sim W. D., Watanasiri S., 2005) [16]

3.1.2 Regeneration of MEG

Natural gas coming from well basically contains a mixture of hydrocarbon, water and dissolved salts. Most salts are formed due to the salt contains in the sea water. Corrosion metal coming from the pipelines has contaminated the content of natural gas. In this closed loop of MEG system, regeneration of MEG is important as to prevent the pipeline from the blockage due to the salts that are believe to plug in the stream. Effort of using MEG as hydrate inhibitor is needed in order to inhibit the formation of hydrates in natural gas. Furthermore, using MEG will decrease cost for the corrosion inhibitor. Regeneration of MEG will remove hydrocarbon and water content in rich MEG as the MEG will be recycled in the closed loop of MEG system and it will be reuse to the greatest extent possible. In this project, only 70% of MEG will be produced at the end of regeneration process. Thus, the regeneration unit that will be used in this paper will be reboiled absorber. Initially, regeneration system of using flash vessel and distillation column is being designed to complete the process. However, it has been decided to use reboiled absorber since it will reduce the capital cost spend on the equipment. In addition, using distillation column will give high purification of lean MEG as the final product which is not our concern. Utility consumption for using reboiled absorber also reduced compared to using distillation column.

3.1.3 Process Description of MEG Regeneration Unit.

Figure 4 shows the MEG regeneration unit. Rich MEG from slug catcher is passes through 3-phase separator V-100 in order to remove hydrocarbon contains in the rich MEG. Bottom product of 3-phase separator V-100 which contains most of water and MEG, and a little of hydrocarbon is passes thorough filter F-100 as to eliminate solid salts coming from deepwater pipelines. Top product from 3-phase separator V-100 which is hydrocarbon will be sent to LP flare for flaring system. Before MEG is feed into reboiled absorber V-101, rich MEG is heated in heat exchanger X-100 since the temperature is too low for the regeneration to happen. In regeneration unit, MEG is boiled to $100^{o}C$ – $150^{o}C$. It is important to monitor the temperature as to preserve the quality of lean MEG that will produce in final product. The boiling point basically will be between the boiling point of water and boiling point of inhibitor. In addition, the temperature should not be more than $204^{o}C$ since MEG will degrade at this point. The overhead product of reboiled absorber will be recycled back into reboiled absorber and some will go to sour water treatment. As for the lean MEG, it will be pumped using booster pump P-101 to the subsea as hydrate inhibitor. However, regeneration process of rich MEG will not remove some of saturated salt contains in the lean MEG after being regenerated in reboiled absorber. Thus, reclamation process is needed in order to reduce the salt content in the lean MEG produced at the end of process.

F-100	:	Filter	V-100	:	3-Phase Separator
P-100	:	Pump	V-101	:	Reboiled Absorber
P-101	:	Pump	X-100/1	:	Heat Exchanger
P-100	:	Booster Pump			

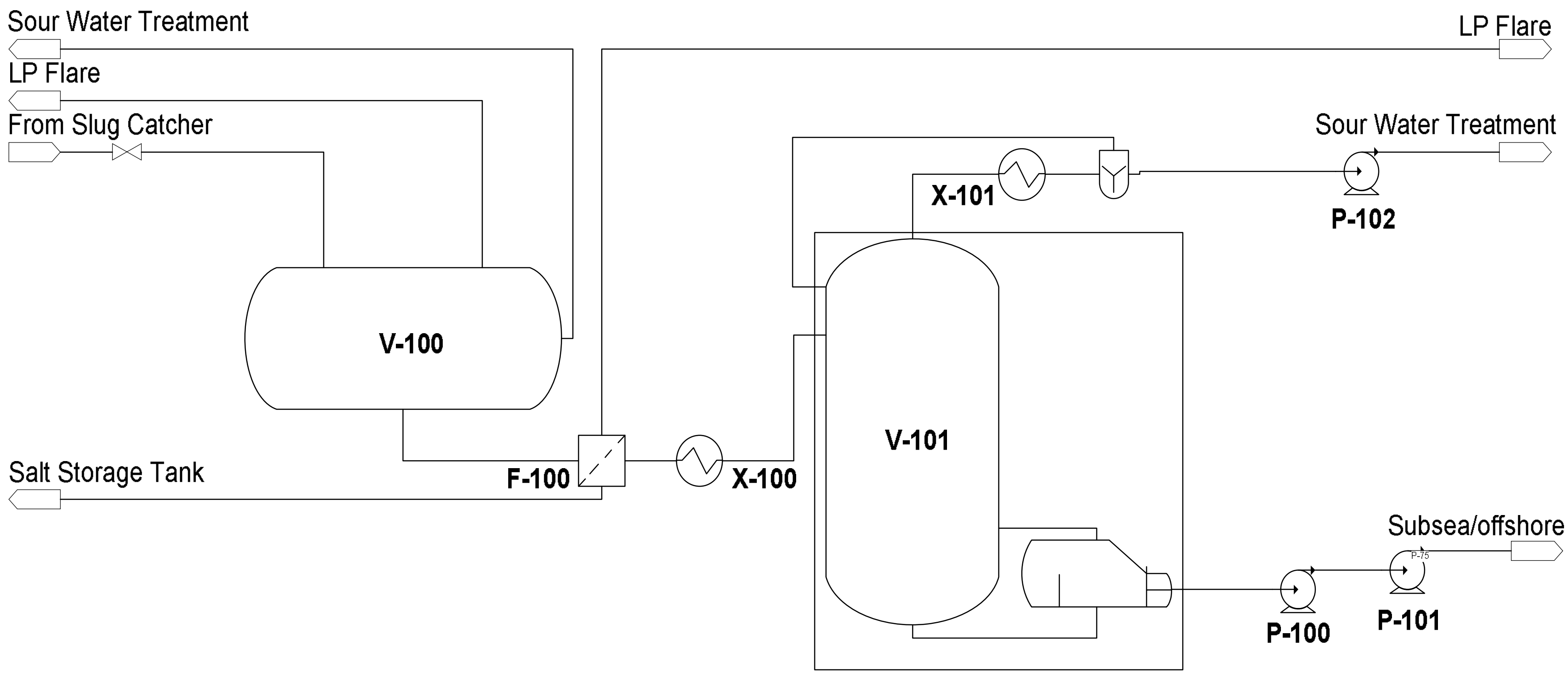

Figure 4: Process Flow Diagram of MEG Regeneration Unit

3.1.4 Regeneration and Reclamation Process

Reclamation process of glycol typically will apply flash vaporization under vacuum in order to remove dissolved salt and suspended solid contaminants. However, there are two overall options for reclamation of MEG, full reclamation and slip stream reclamation. The needs of reclamation unit is essential in order to remove salt since salt is non-volatile [10]. During regeneration of MEG, non-volatile salt will remain in regeneration unit as water is boiled off. If there is no reclamation unit in this system, salt will continuously enter the glycol system, and its concentration will keep increasing during each regeneration cycle since salt is not removed from the system. This will lead to plugging and formation of precipitation that will cause several equipments to foul.

3.1.5 Full Reclamation (Evaporating the total rich MEG)

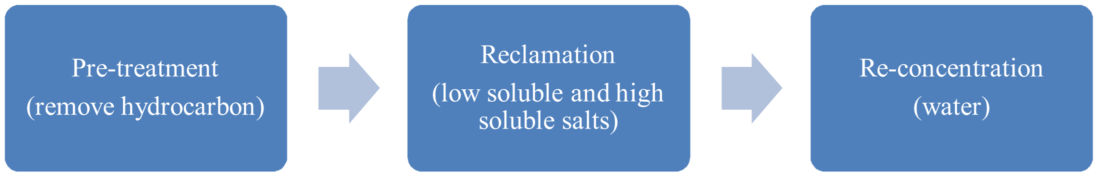

Figure 5: Stages of removing impurities from rich MEG

Full reclamation of MEG is selected when there is huge amount of water coming from slug catcher . As for full reclamation system, its principle is to remove all salt content in rich MEG as to prevent scaling in the pipelines. In full reclamation, rich MEG will undergo pre-treatment where hydrocarbon will be removed before entering the reclamation unit. Referring to Figure 6, 3-phase separator V-100 will be used in removing hydrocarbon contents in rich MEG. Rich MEG from will enter vacuum reboiler V-101 where it will be evaporated between the boiling point of water and MEG. All water and MEG will be in vapor phase while salt will remain in the flash separator. The evaporated MEG will be re-concentrated in reboiled absorber V-103 instead of distillation column as discussed previously. Essentially, all salt and non-volatile chemicals remain in flash separator will be sent to solid handling units F-102 as to remove salt and to recycle back into vacuum reboiler V-102. However, full reclamation is said will consume high energy since the entire MEG and water need to be vaporized. There are several oil and gas plant that apply full reclamation which are STOS (Shell Todd, New Zealand) Statoil Asgard B, Britannia Satellites and BP Shah Deniz [10].

F-100/ 1	:	Filter	V-101	:	Vacuum Reboiler
P-100/ 1/2/3/4	:	Pump	V-102	:	Reboiled Absorber
V-100	:	3-Phase Separator	X-100/1/2	:	Heat Exchanger

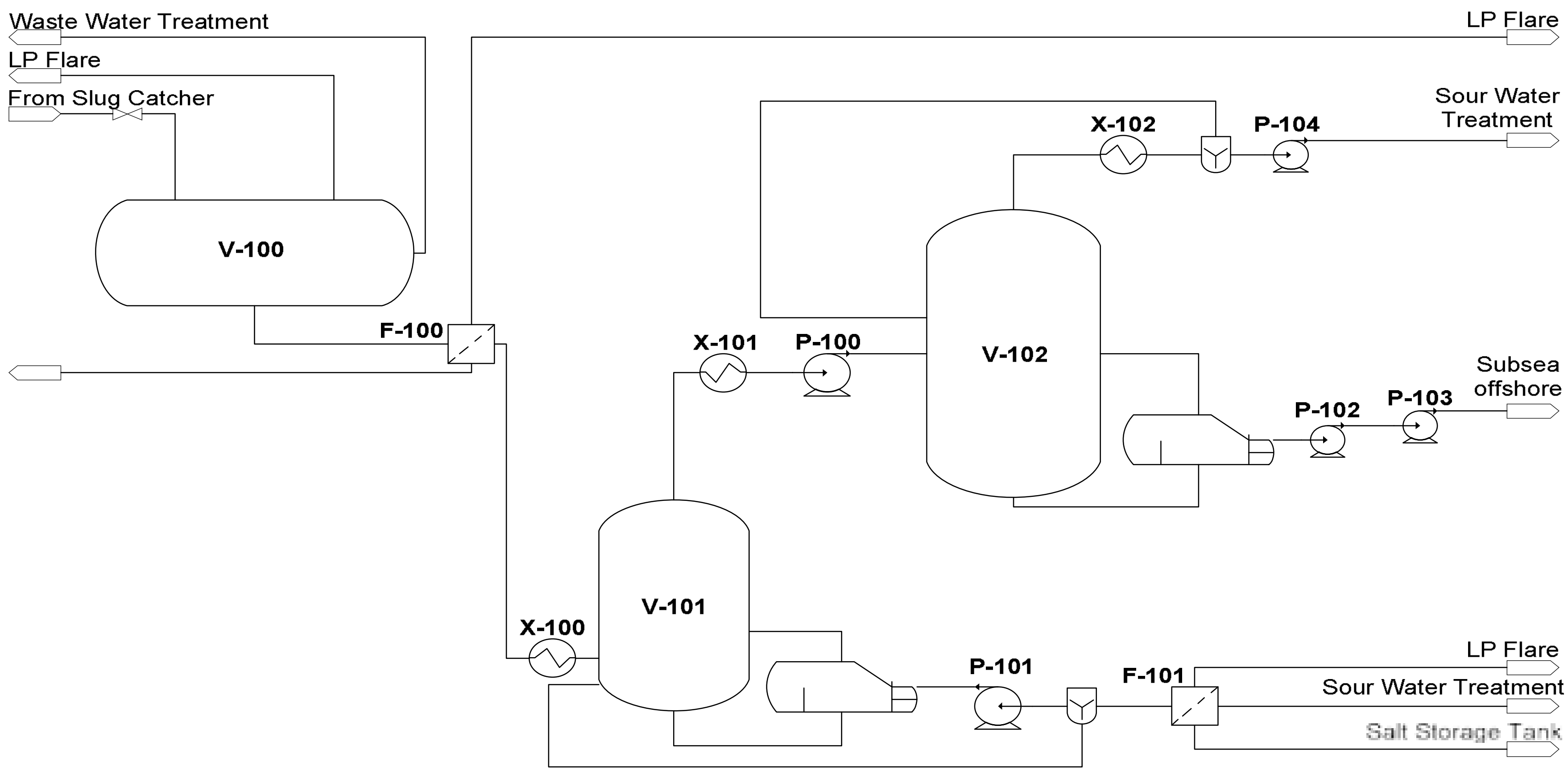

Figure 6: Process Flow Diagram of Full Reclamation of MEG

3.1.6 Slip Stream Reclamation

Slip stream reclamation is reclamation of partially remove salt and contaminants from rich MEG. From Figure 7, rich MEG is first has to pass thorough regeneration unit V-100 before reclamation process. Regeneration of MEG will remove huge amount of water and lean MEG produce will be split into two paths, which one part will go for slip stream reclamation process V-101. In reclamation process, lean MEG is evaporating in vacuum reboiler V-102 or flash separator. In this reclamation, only part of salt and corrosion substances will be removed. However, the salts remained cannot exceed allowable salt contains in lean MEG as to prevent the blockage and corrosion due to formation of hydrates in pipelines. The slip stream reclamation is believed more effective than full reclamation process [17]. Other than that, it required small size of reclaimer unit compared to full reclamation and at the same time can reduce the criticality of reclaimer. However, there is disadvantage of slip stream, which impurities will accumulate in closed loop of MEG system since only part of salt is being removed in reclamation process. Here is listed ongoing projects of applying slip stream reclamation; Ormen Lange and Snohvit/ Hammerfest (Statoil Norway)[10].

F-100/ 1	:	Filter	V-101	:	Reboiled Absorber
P-100/ 1/2/3/	:	Pump	V-102	:	Vacuum Reboiler
V-100	:	3-Phase Separator	X-100/1/2	:	Heat Exchanger

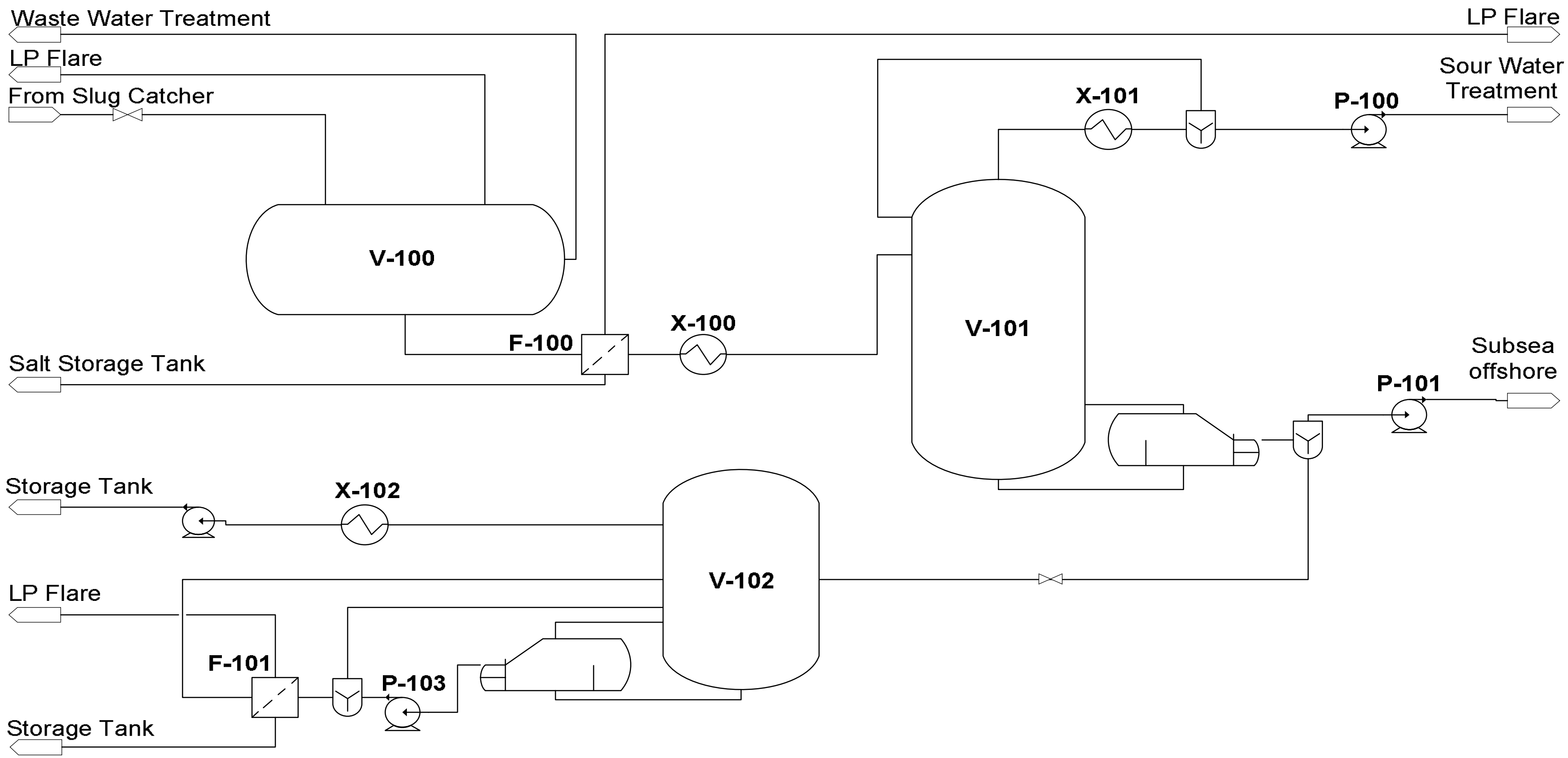

Figure 7: Process Flow Diagram of Reclamer MEG with 20% Slip- Stream

CHAPTER 4

4.1 Results and Discussion

In this chapter, the results of simulation will be explained in details. There are three cases for this project, which consist of regeneration of MEG, full reclamation and reclamer MEG with 20% slip- stream. However, regeneration of MEG is considered as base case for this simulation. The reclamation cases will be compared to the base case in term of utilities consumption. Other than that, the are several validation of simulation have been done as to validate the three cases. Basically, all validation are being presented in graph as to make it easier in order to observe any changes that has been made.

4.1.1 Regeneration of MEG

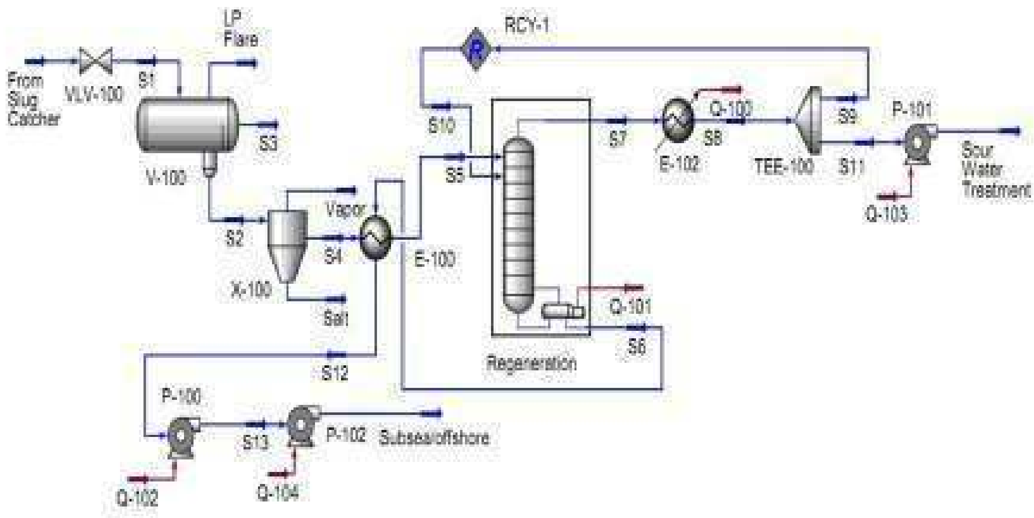

Figure 8: Regeneration of MEG using Hysys.

Simulation attached above is the regeneration of MEG by using HYSYS software 2006. Objective of producing 70% weight of MEG as final product is achieved.

Regeneration of MEG

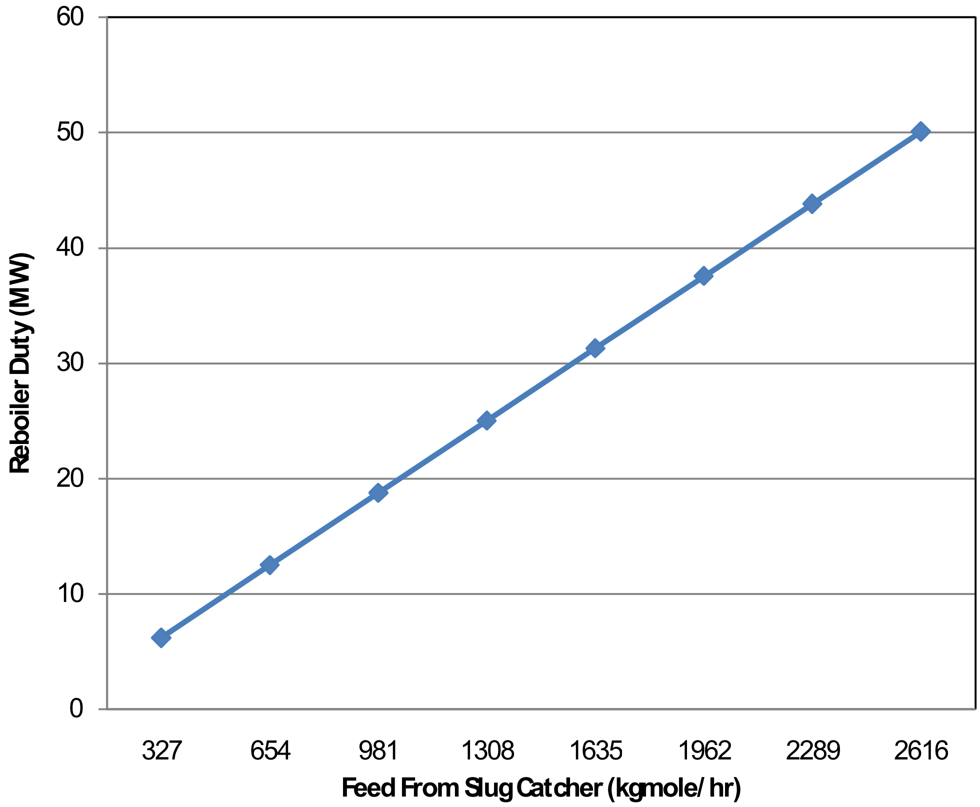

Figure 9: Effect of Feed Flow Rate on Reboiler Duty in MEG Regeneration Unit

Table 4: Effect of Feed Flow Rate to Reboiler Duty

Feed	Q (kJ/hr)	MW
327	22393371	6.22
654	45065291	12.52
981	67610002	18.78
1308	**90147492**	**25.04**
1635	112684830	31.3
1962	135222537	37.56
2289	157759220	43.82
2616	180295777	50.08

Figure 9 shows the effect of feed flow to reboiler duty. For simulation of regeneration of MEG, 1308 kgmole/hr of rich MEG is feed to the regeneration unit in order to produce 70% weight of MEG and 30% weight of water in lean MEG. In order to observe the effect between changing in feed flow rate and reboiler duty, graph in Figure 9 attached is plotted by manipulating feed flow. Feed flow is being tabulated by 25% increment and decrement from the given feedstock which is 1308 kgmole/hr. It is concluded that when feed is increasing, reboiler duty will increase as well as to compensate the increment in inlet of reboiled absorber. However, when feed flow is lower than 1308 kgmole/hr, the MEG tends to degrade in order to achieve 70% weight of MEG.

Table 5: Mass Flow of Stream

Feed (kgmole/hr)	T_1 (°C)	T_2 (°C)	Mass flow of steam (kg/hr)
981	85	204.8	446044.4
1308	**85**	**164.9**	**558787.5**
1635	85	159.1	721135.2
1962	85	156.6	746312.6
2289	85	155.2	761198.3
2616	85	154.4	769972.9

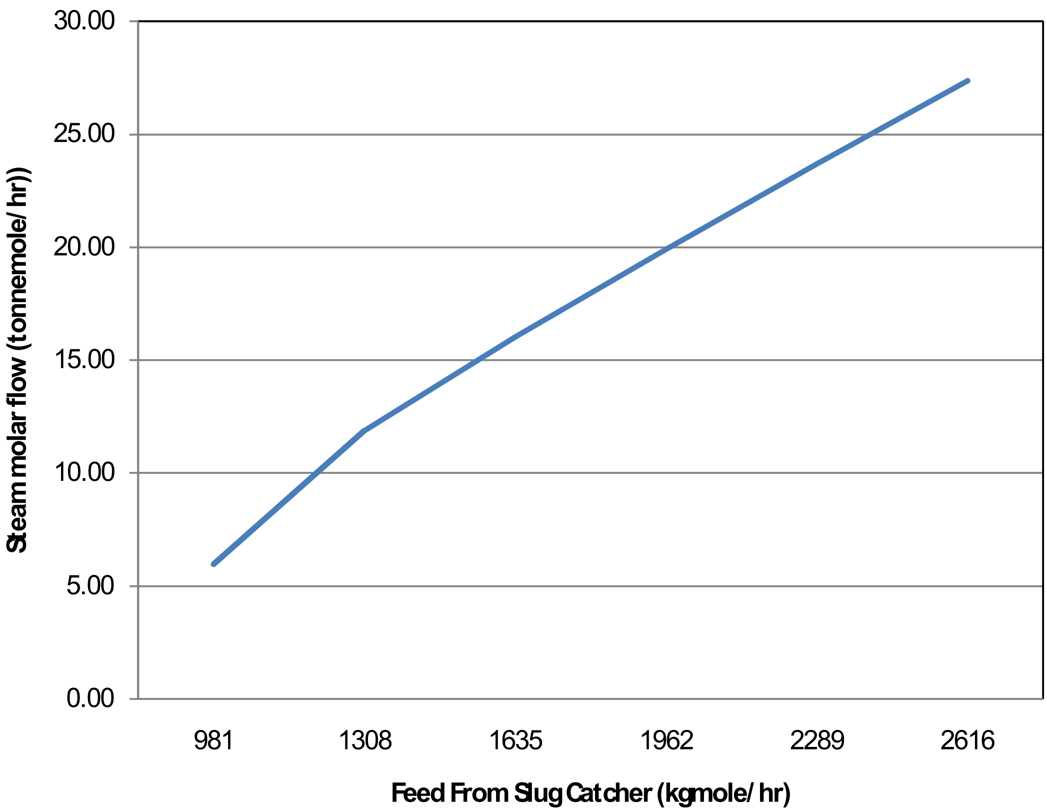

Figure 10: Effect of Feed Flow Rate on Steam Consumption in MEG Regeneration Unit

Figure 10 above shows the variation of mass flow rate of steam when feed flow is increased by 25% of given feed flow. Referring to graph, steam flow will increase when feed flow from slug catcher increase. This trend of graph is expected since steam flow has to compensate changes of inlet coming to reboiled absorber. To add more, for this validation, final composition of MEG is maintained 70% weight of MEG as final product. As conclusion, simulation of MEG regeneration unit is valid until this point as flow of steam should be proportional to steam flow rate of reboiled absorber.

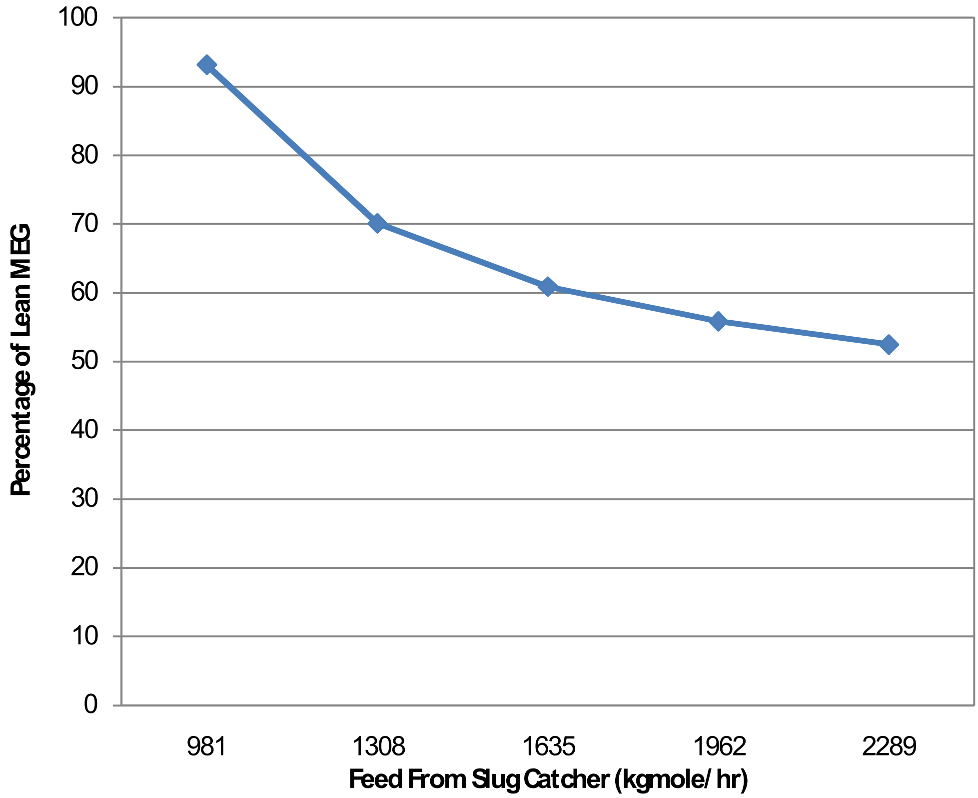

Figure 11: Effect of Feed Flow Rate on Percentage of Lean MEG in MEG Regeneration Unit

Table 6: Percentage of Lean MEG

Feed	(y) MEG
327	N/A
654	N/A
981	0.931449
1308	**0.700948**
1635	0.609059
1962	0.558511
2289	0.524917

In Figure 11, we studied the effect of feed flow rate on percentage of lean MEG produced at the end of this system. Theoretically, when heat duty is kept constant, any changes either increasing or decreasing of feed flow, will affect the final percentage of lean MEG. Feed flow rate should be inversely proportional with percentage of lean MEG, as quality increase when quantity decreases. For this graph, heat supply is kept at 25.04616 MW, and feed flow is being manipulated in order to observe the changes to lean MEG. Referring to graph plotted above, we can see that real time simulation did give expected result as per theory. However, this simulation cannot compensate for very small feed flow coming from slug catcher when heat supply is 25.04616 MW.

4.1.2 Reclamation of MEG

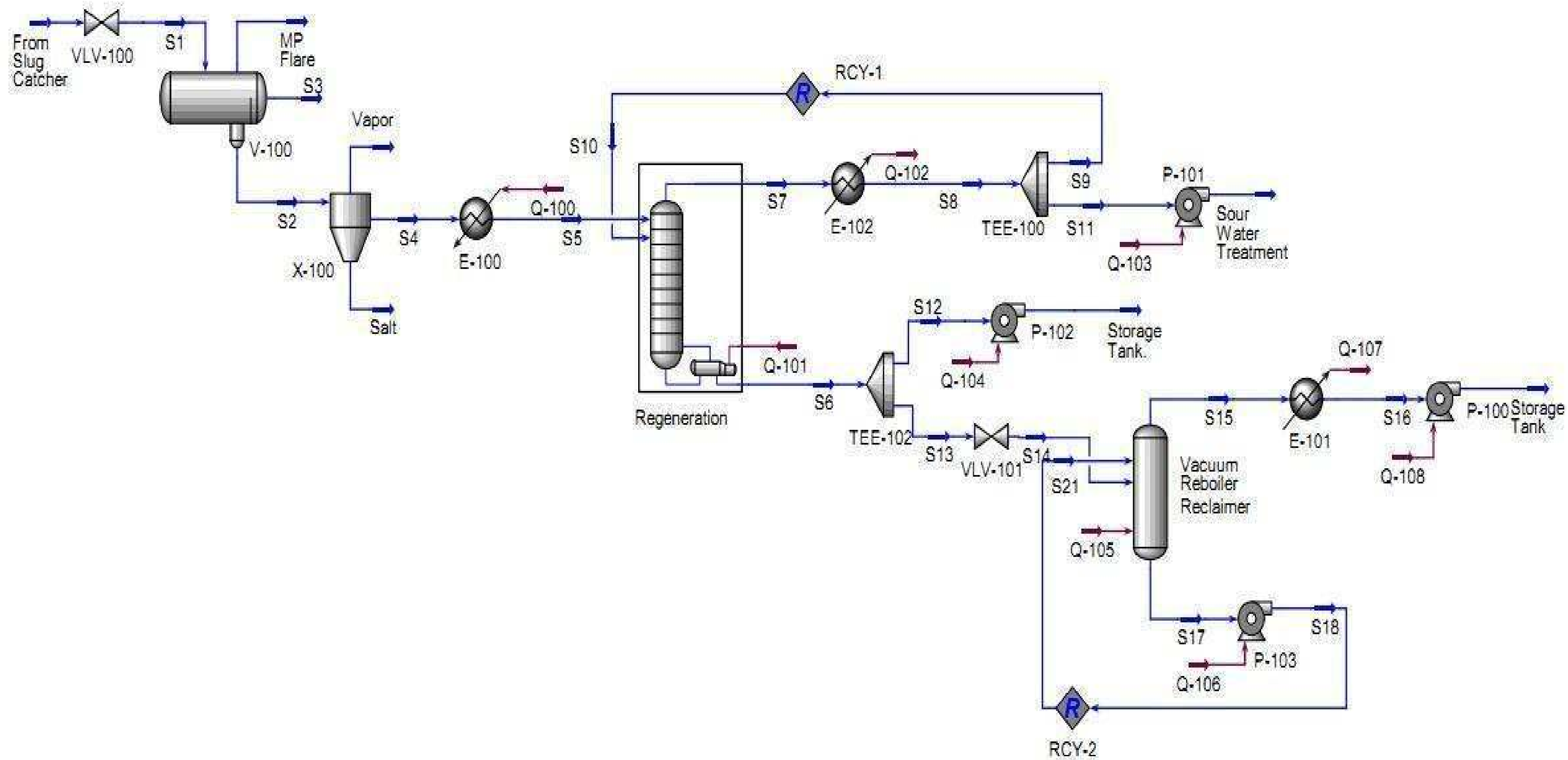

Figure 12: Reclamer MEG with 20% Slip- Stream

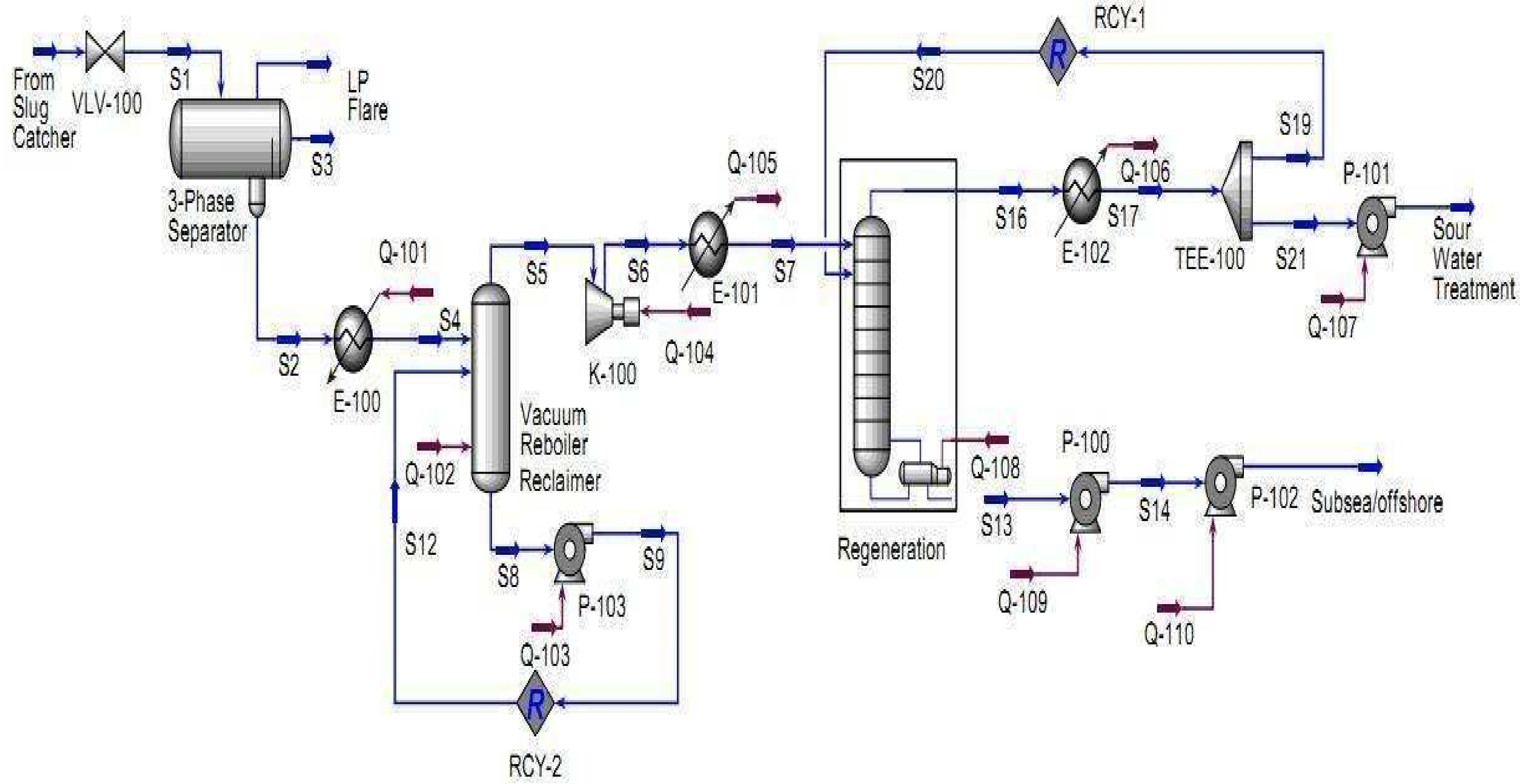

Figure 13: Full reclamation of MEG

Table 7: Utilities Consumption

	Cooling Utilities MW)	Heating Utilities (MW)
Full Reclamation	25.4713	1.9824
	10.5127	16.1632
		14.6473
Slip Stream Reclamation	24.8271	2.0947
	2.3029	1.4695
		24.9222

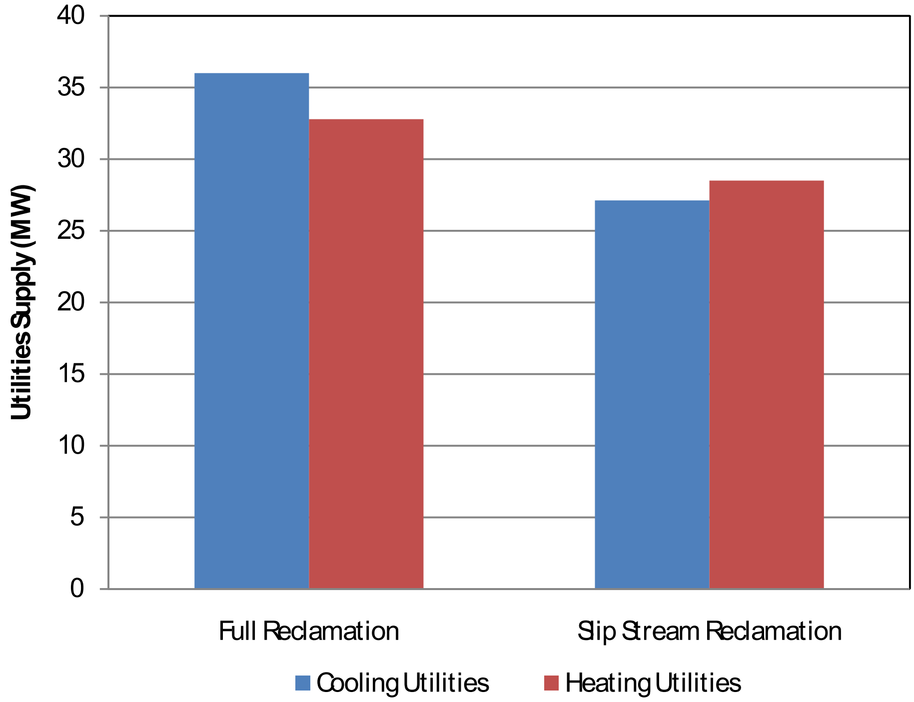

Figure 14: Utilities Consumption for Full Reclamation and Slip Stream Reclamation

From Figure 14, it is observed that full reclamation consumed higher heating medium in order to vaporize total rich MEG compared to slip stream reclamation. Furthermore, cooling medium consumption for full reclamation also is higher compared to cooling medium consumption for slip stream reclamation [21].

Table 8: Utilities for Regeneration and Reclamation

	Regeneration (MW)	Reclamation (MW)
Full Reclamation	50.6314	18.1455
Slip Stream Reclamation	51.2188	4.3975

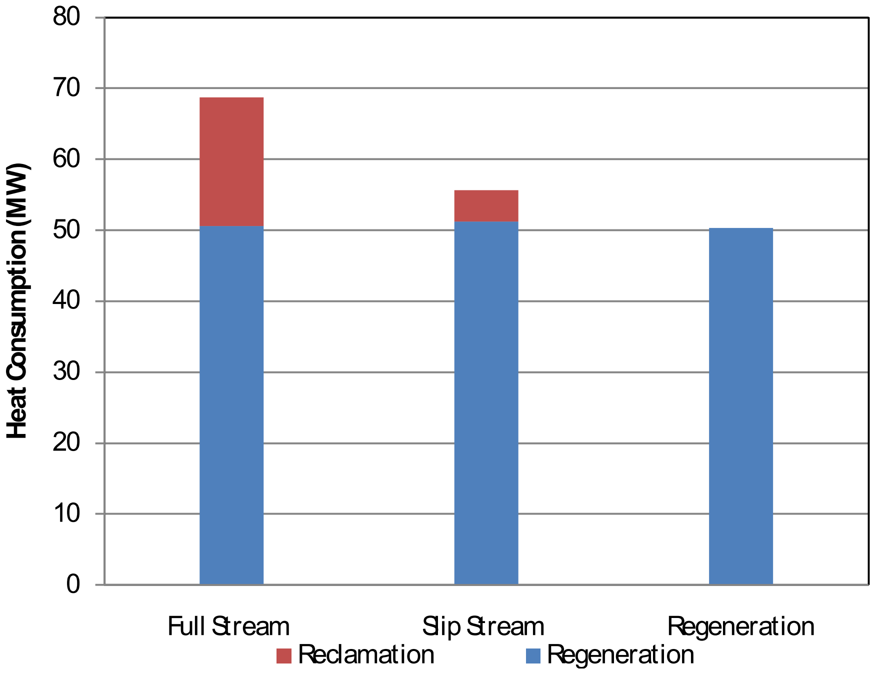

Figure 15: Utilities for Reclamation versus Regeneration

Figure 15 above shows the comparison of total utilities needed for both regeneration and reclamation system. From the plotted bar chart, it can be concluded that full reclamation consume more utilities compared to slip stream reclamation. However, both systems have same quantity of utilities for regeneration system since the feed stock is kept constant in this simulation. Other than that, slip stream reclamation has one third of utilities for reclamation compared to full reclamation. This happens because part of total lean MEG is feed to the reclaimer compared to full reclamation that has total rich MEG that is being reclaimed. However, to compare for all three cases, regeneration of MEG will consume least amount of utilities compared to others. Regeneration of MEG without reclamation can be implemented only when salt contains in rich MEG is not a big issues.

However, salt issues cannot be solved using HYSYS, the purpose of having reclamations simulation is to compare the utilities needed for both reclamations.

Salt issues will be discussed in details that consist of types of salts, how to remove salt and current technology being applied in plant on how to remove salts.

4.1.3 Salt and Scale

Salt contains in lean MEG is the most crucial problem to be encountered in any regeneration and reclamation of MEG and for this process simulation, the salt contains is said to be 3 tonne/day. Precipitation of this salt is said can foul the system in which it will plug in solid handling equipment, foul the filter and heat exchanger and accumulate in regeneration units, and thus resulting in high glycol losses because of thermal degradation and to the extend the plant is shutting down due to maintenance. Basically there are salt coming or formed from sea water, and there are salt coming from the corrosion of pipeline, scale and from completion fluids. Besides, the aqueous phase of glycol is likely to contain other chemical that are being used in transportation and production process such as scale inhibitor, drilling fluids, pH stabilizer and pipeline conservation fluids. These impurities will accumulate and precipitate in a closed loop system of MEG if not being taken care of. There are two types of cations (salt) formed from formation of water;

Monovalent cations: Sodium (Na^+), Potassium,(K^+), Chloride (Cl^-), and etc.
Divalent cations: Calcium (Ca2+), Magnesium (Mg2+), Barium (Ba2+) and etc.

Concentrations of these salts are higher since large portion of rich MEG consist of water. Precipitate will form as this salt is reacted with carbonates and suphates, which are the alkalinity ions. Salt crystals will continuously precipitate from the contact of divalent ions and alkalinity in the liquid as vapor evolves from flash separator. High concentration of divalent cations is present in rich MEG compared to alkalinity ions, thus precipitate formed is highly dependent on concentration of alkalinity ions. In order to produce more precipitate, it is important to control the alkalinity in flash separator. This can be done by injecting bicarbonate/ carbonate in order to ramp up the formation of precipitation in flash separator. This measure gives significant values as it will increase the capacity of reclaimer and also can reduce foaming and carry over in reclaimer unit, thus maintenance and cleaning needed for reclaimer unit can be minimized [10].

Furthermore, according to International for Energy Technology (IFE), if concentration of small particles is high compare to NaCl, it is expected that solid handling centrifuge will experience difficulties in removing entire small particle and accumulation is likely to happen [20]. Basically, these small particles consist of different carbonates which are Na_2CO_3, $CaCO_3$, FeCO3 and Fe_3O_4. This small particles is said will stick to NaCl if the concentration of those small particles can be kept as lower as possible and can be remove by solid handling equipment [20]. As for the Shah Deniz plant, they have come with an alternative or back-up facility by *injecting NaCl into flash separator*. This will increase the concentration of NaCl in rich MEG thus makes the concentration of small particles getting lower. Consequently this action will let small particles to stick to NaCl and can be easily removed in solid handling equipment.

Due to corrosion in glycol system, the glycol passing through the system will contain some corrosion products consists of iron ions and solids such as iron carbonate, iron oxides and etc. Other than that, the corrosion process also will release traces of other metal from pipeline and equipment, for example chromium, copper, nickel, manganese and etc. There are several ways of reducing the formation of scale and corrosion [17].

- Reduces MEG auto-oxidation that can reduce the breakdown of MEG into organic acid.
- Control the solubility of and precipitation that is likely to happen in flash vessel.
- Neutralizes carbon dioxide.

In slip stream reclamation unit, lean MEG entering reclamation unit basically will be the effluent of regeneration unit. During the regeneration of MEG, most non-volatile salt remains in lean MEG as water is boiled off. Lean MEG with non-volatile salt is feed to reclamation unit in order to remove salt that remains in lean MEG. According to US patent (US20100191023 A1), several MEG regeneration projects involved in removal or reduction of alkali metals salts such as calcium chloride from contaminated MEG (James C.T Chen). Other than that, in some salt removal's effort, there is an effort of converting salts to carbonates that can be removed as precipitation particulates.

However, in some MEG reclamation system, sodium carbonate (Na_2CO_3) is injected into MEG stream contains alkali metal salt such as calcium chloride ($CaCl_2$) in order to precipitate out calcium carbonate ($CaCO_3$) that can be removed in solid handling unit. Unfortunately, precipitate of $CaCO_3$ formed is too small in size thus make it difficult to filter out. In some patent, it has been discovered that by injecting $CaCO_3$ to the MEG stream, crystal or larger particle is formed compare to precipitate formed from previous step. There is different method for preventing corrosion in flow lines, at the same time controlling the scale deposition. Common method is to increase pH by adding basic agent to the MEG stream. However, this will give adverse effect since an increase in pH by a unit will reduce the solubility of divalent ions by two orders of magnitude (S. Kristian, 2006).

4.2 Software

Figure 1.1

4.3 Gant Chart

		Final Year Semester 1														
No	**Details/ Week**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
1	Selection of project title															
2	Preliminary research work															
3	Submission of extended proposal															
4	Proposal defense															
5	Projet work continues															
6	Submission of interim draft report															
7	Submission of interim report															
		Final Year Semester 2														
1	Projet work continues															
2	Testing simulation															
3	Submission of progress report															
4	Pre-SEDEX															
5	Submission of draft report															
6	Submission of dissertation report															
7	Submission of technical paper															
8	Oral presentation															
9	Submission of project dissertation															

CHAPTER 5

5.1 Conclusion and Recommendation

Regeneration of MEG with 70% wt of lean MEG can reduce the capital cost for MEG system. In this work, we developed the regeneration of MEG using reboiled absorber as to achieve desired lean MEG. Reclamation unit is included since regeneration unit incapable of removing salt content in rich MEG. Without reclamation of MEG, all salt will re-circulate and cause blockage to the system. This simulation is verified to ensure regeneration of MEG unit is working properly.

As for recommendation, I would like to suggest next peer to study about salt and how to remove large amount of salt during regeneration of MEG and also to find the difference between ion exchange method and injection of chemical to MEG stream. From this research, it was found that, in order to remove salt contains in natural gas is by softening and ion exchange. In order to apply in this system, a further study is required to investigate the effect of glycol on mechanism of ion exchange. However, from ion exchange method, the precipitate will come out. It is conclude that this result is similar with injection of chemical to MEG stream. Further study should be done as to solve the salt issues.

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Appendices

[1] Workbook for Simulation of MEG Regeneration Unit

[2] Workbook for Simulation of Full Stream Reclamation Unit

[3] Workbook for Simulation of Slip- Stream Reclamation Unit

Workbook: Case (Main)

Material Streams

Fluid Pkg: All

Name		S6	S12	From Slug Catcher	LP Flare	S5
Vapour Fraction		0.0000	0.0000	0.0013	1.0000	0.0000
Temperature	(C)	145.7	63.79	41.30 *	41.36	85.00 *
Pressure	(kPa)	250.0	240.0	600.0 *	200.0	200.0
Molar Flow	(kgmole/h)	542.9	542.9	1308 *	2.066	1306
Mass Flow	(kg/h)	1.944e+004	1.944e+004	3.345e+004	54.75	3.340e+004
Liquid Volume Flow	(m3/h)	18.09	18.09	32.19	0.1187	32.07
Heat Flow	(kJ/h)	-1.841e+008	-1.894e+008	-4.086e+008	-2.578e+005	-4.030e+008
Name		S7	Subsea/offshore	S1	S8	S11
Vapour Fraction		1.0000	0.0000	0.0016	0.0000	0.0000
Temperature	(C)	116.1	65.20	41.36	20.00 *	20.00
Pressure	(kPa)	150.0	1.501e+004 *	200.0 *	250.0 *	250.0
Molar Flow	(kgmole/h)	1907	542.9	1308	1907	763.0
Mass Flow	(kg/h)	3.490e+004	1.944e+004	3.345e+004	3.490e+004	1.396e+004
Liquid Volume Flow	(m3/h)	34.95	18.09	32.19	34.95	13.98
Heat Flow	(kJ/h)	-4.565e+008	-1.890e+008	-4.086e+008	-5.477e+008	-2.191e+008
Name		S13	Vapor	S4	Salt	S9
Vapour Fraction		0.0000	1.0000	0.0000	0.0000	0.0000
Temperature	(C)	63.83	41.36	41.36	41.36	20.00
Pressure	(kPa)	600.0 *	200.0	200.0	200.0	250.0
Molar Flow	(kgmole/h)	542.9	0.0000	1306	0.0000	1144
Mass Flow	(kg/h)	1.944e+004	0.0000	3.340e+004	0.0000	2.094e+004
Liquid Volume Flow	(m3/h)	18.09	0.0000	32.07	0.0000	20.97
Heat Flow	(kJ/h)	-1.894e+008	0.0000	-4.083e+008	0.0000	-3.286e+008
Name		Sour Water Treatmen	S10	S2	S3	
Vapour Fraction		0.0000	0.0000	0.0000	0.0000	
Temperature	(C)	20.03	20.00 *	41.36	41.36	
Pressure	(kPa)	600.0 *	250.0 *	200.0	200.0	
Molar Flow	(kgmole/h)	763.0	1144 *	1306	0.0000	
Mass Flow	(kg/h)	1.396e+004	2.094e+004	3.340e+004	0.0000	
Liquid Volume Flow	(m3/h)	13.98	20.97	32.07	0.0000	
Heat Flow	(kJ/h)	-2.191e+008	-3.286e+008	-4.083e+008	0.0000	

Compositions

Fluid Pkg: All

Name	S6	S12	From Slug Catcher	LP Flare	S5
Comp Mole Frac (Methane)	0.0000	0.0000	0.0008 *	0.5063	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0002 *	0.1197	0.0000
Comp Mole Frac (Propane)	0.0000	0.0000	0.0001 *	0.0652	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000 *	0.0006	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000 *	0.0013	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000 *	0.0063	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000 *	0.0006	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000 *	0.0043	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (CO2)	0.0000	0.0000	0.0006 *	0.1534	0.0004
Comp Mole Frac (H2S)	0.0000	0.0000	0.0011 *	0.1065	0.0010
Comp Mole Frac (H2O)	0.5963	0.5963	0.8264 *	0.0337	0.8276
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000 *	0.0003	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000 *	0.0014	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000 *	0.0002	0.0000
Comp Mole Frac (EGlycol)	0.4037	0.4037	0.1707 *	0.0001	0.1710

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name	S7	Subsea/offshore	S1	S8	S11
Comp Mole Frac (Methane)	0.0000	0.0000	0.0008	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0002	0.0000	0.0000
Comp Mole Frac (Propane)	0.0000	0.0000	0.0001	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0007	0.0000	0.0006	0.0007	0.0007
Comp Mole Frac (H2S)	0.0017	0.0000	0.0011	0.0017	0.0017
Comp Mole Frac (H2O)	0.9923	0.5963	0.8264	0.9923	0.9923
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.0053	0.4037	0.1707	0.0053	0.0053

Name	S13	Vapor	S4	Salt	S9
Comp Mole Frac (Methane)	0.0000	0.5063	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.1197	0.0000	0.0000	0.0000
Comp Mole Frac (Propane)	0.0000	0.0652	0.0000	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0006	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0013	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0063	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0006	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0043	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0000	0.1534	0.0004	0.0004	0.0007
Comp Mole Frac (H2S)	0.0000	0.1065	0.0010	0.0010	0.0017
Comp Mole Frac (H2O)	0.5963	0.0337	0.8276	0.8276	0.9923
Comp Mole Frac (M-Mercaptan)	0.0000	0.0003	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0014	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0002	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.4037	0.0001	0.1710	0.1710	0.0053

Name	Sour Water Treatmen	S10	S2	S3	
Comp Mole Frac (Methane)	0.0000	0.0000 *	0.0000	0.0268	
Comp Mole Frac (Ethane)	0.0000	0.0000 *	0.0000	0.0336	
Comp Mole Frac (Propane)	0.0000	0.0000 *	0.0000	0.0568	
Comp Mole Frac (i-Butane)	0.0000	0.0000 *	0.0000	0.0014	
Comp Mole Frac (n-Butane)	0.0000	0.0000 *	0.0000	0.0041	
Comp Mole Frac (i-Pentane)	0.0000	0.0000 *	0.0000	0.0000	
Comp Mole Frac (n-Pentane)	0.0000	0.0000 *	0.0000	0.0000	
Comp Mole Frac (Benzene)	0.0000	0.0000 *	0.0000	0.3541	
Comp Mole Frac (p-Xylene)	0.0000	0.0000 *	0.0000	0.3415	
Comp Mole Frac (Nitrogen)	0.0000	0.0000 *	0.0000	0.0001	
Comp Mole Frac (Oxygen)	0.0000	0.0000 *	0.0000	0.0000	
Comp Mole Frac (CO2)	0.0007	0.0007 *	0.0004	0.0333	
Comp Mole Frac (H2S)	0.0017	0.0017 *	0.0010	0.0862	
Comp Mole Frac (H2O)	0.9923	0.9923 *	0.8276	0.0258	
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000 *	0.0000	0.0017	
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000 *	0.0000	0.0193	
Comp Mole Frac (nPMercaptan)	0.0000	0.0000 *	0.0000	0.0145	
Comp Mole Frac (EGlycol)	0.0053	0.0053 *	0.1710	0.0007	

Workbook: Case (Main) (continued)

Energy Streams

Fluid Pkg: All

Name		Q-101	Q-102	Q-100	Q-103	Q-104
Heat Flow	(kJ/h)	9.101e+007	8821	9.117e+007	6544	3.530e+005

Unit Ops

Operation Name	Operation Type	Feeds	Products	Ignored	Calc Level
E-100	Heat Exchanger	S4	S5	No	500.0 *
		S6	S12		
Regeneration	Reboiled Absorber	S5	S7	No	2500 *
		S10	S6		
		Q-101			
P-100	Pump	S12	S13	No	500.0 *
		Q-102			
P-101	Pump	S11	Sour Water Treatment	No	500.0 *
		Q-103			
P-102	Pump	S13	Subsea/offshore	No	500.0 *
		Q-104			
VLV-100	Valve	From Slug Catcher	S1	No	500.0 *
E-102	Cooler	S7	S8	No	500.0 *
			Q-100		
X-100	Simple Solid Separator	S2	Salt	No	500.0 *
			Vapor		
			S4		
TEE-100	Tee	S8	S9	No	500.0 *
			S11		
RCY-1	Recycle	S9	S10	No	3500 *
V-100	3 Phase Separator	S1	S3	No	500.0 *
			LP Flare		
			S2		

LEGENDS
Calgary, Alberta
CANADA

Case Name:	D:\SIMULATION OF MEG (FULL RECLAMATION).HSC
Unit Set:	SI
Date/Time:	Fri Jan 04 03:11:09 2013

Workbook: Case (Main)

Material Streams

Fluid Pkg: All

Name		S13	From Slug Catcher	LP Flare	S16	Subsea/offshore
Vapour Fraction		0.0000	0.0014	1.0000	1.0000	0.0000
Temperature	(C)	124.2	41.30 *	41.30	118.6	129.0
Pressure	(kPa)	130.0	600.0 *	300.0	110.0	1.501e+004 *
Molar Flow	(kgmole/h)	514.1	1308 *	2.145	1979	514.1
Mass Flow	(kg/h)	1.841e+004	3.345e+004	57.89	3.745e+004	1.841e+004
Liquid Volume Flow	(m3/h)	17.14	32.19	0.1204	37.33	17.14
Heat Flow	(kJ/h)	-1.763e+008	-4.087e+008	-3.094e+005	-4.773e+008	-1.760e+008

Name		S1	S17	S21	S14	S19
Vapour Fraction		0.0016	0.0000	0.0000	0.0000	0.0000
Temperature	(C)	41.30	30.00 *	30.00	124.3	30.00
Pressure	(kPa)	300.0 *	350.0 *	350.0	600.0 *	350.0
Molar Flow	(kgmole/h)	1308	1979	791.6	514.1	1187
Mass Flow	(kg/h)	3.345e+004	3.745e+004	1.498e+004	1.841e+004	2.247e+004
Liquid Volume Flow	(m3/h)	32.19	37.33	14.93	17.14	22.40
Heat Flow	(kJ/h)	-4.087e+008	-5.690e+008	-2.276e+008	-1.763e+008	-3.414e+008

Name		Sour Water Treatmen	S20	S2	S3	S5
Vapour Fraction		0.0000	0.0000	0.0000	0.0000	1.0000
Temperature	(C)	30.01	30.00 *	41.30	41.30	120.0 *
Pressure	(kPa)	400.0 *	350.0 *	300.0	300.0	15.00
Molar Flow	(kgmole/h)	791.6	1187 *	1306	0.0000	1306
Mass Flow	(kg/h)	1.498e+004	2.247e+004	3.340e+004	0.0000	3.340e+004
Liquid Volume Flow	(m3/h)	14.93	22.39	32.07	0.0000	32.07
Heat Flow	(kJ/h)	-2.276e+008	-3.414e+008	-4.084e+008	0.0000	-3.430e+008

Name		S8	S6	S7	S9	S12
Vapour Fraction		0.0000	1.0000	0.6359	0.0000	0.0000
Temperature	(C)	120.0 *	340.7	130.0 *	120.1	120.1 *
Pressure	(kPa)	15.00	150.0 *	150.0 *	300.0 *	300.0 *
Molar Flow	(kgmole/h)	0.0000	1306	1306	0.0000	0.0000 *
Mass Flow	(kg/h)	0.0000	3.340e+004	3.340e+004	0.0000	0.0000
Liquid Volume Flow	(m3/h)	0.0000	32.07	32.07	0.0000	0.0000
Heat Flow	(kJ/h)	0.0000	-3.272e+008	-3.650e+008	0.0000	0.0000

Name		S4				
Vapour Fraction		0.0000				
Temperature	(C)	100.0 *				
Pressure	(kPa)	300.0 *				
Molar Flow	(kgmole/h)	1306				
Mass Flow	(kg/h)	3.340e+004				
Liquid Volume Flow	(m3/h)	32.07				
Heat Flow	(kJ/h)	-4.012e+008				

* Specified by user.

Workbook: Case (Main) (continued)

Compositions

Fluid Pkg: All

Name	S13	From Slug Catcher	LP Flare	S16	Subsea/offshore
Comp Mole Frac (Methane)	0.0000	0.0008 *	0.4874	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0002 *	0.1153	0.0000	0.0000
Comp Mole Frac (Propane)	0.0000	0.0001 *	0.0327	0.0001	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000 *	0.0001	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000 *	0.0002	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000 *	0.0043	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0000	0.0006 *	0.2219	0.0004	0.0000
Comp Mole Frac (H2S)	0.0000	0.0011 *	0.1158	0.0016	0.0000
Comp Mole Frac (H2O)	0.5961	0.8264 *	0.0222	0.9781	0.5961
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.4039	0.1707 *	0.0000	0.0197	0.4039
Name	**S1**	**S17**	**S21**	**S14**	**S19**
Comp Mole Frac (Methane)	0.0008	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0002	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Propane)	0.0001	0.0001	0.0001	0.0000	0.0001
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0006	0.0004	0.0004	0.0000	0.0004
Comp Mole Frac (H2S)	0.0011	0.0016	0.0016	0.0000	0.0016
Comp Mole Frac (H2O)	0.8264	0.9781	0.9781	0.5961	0.9781
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.1707	0.0197	0.0197	0.4039	0.0197
Name	**Sour Water Treatmen**	**S20**	**S2**	**S3**	**S5**
Comp Mole Frac (Methane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Propane)	0.0001	0.0001 *	0.0000	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0004	0.0004 *	0.0003	0.0003	0.0003
Comp Mole Frac (H2S)	0.0016	0.0016 *	0.0010	0.0010	0.0010
Comp Mole Frac (H2O)	0.9781	0.9782 *	0.8277	0.8277	0.8277
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.0197	0.0197 *	0.1710	0.1710	0.1710

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name	S8	S6	S7	S9	S12
Comp Mole Frac (Methane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Propane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (CO2)	0.0000	0.0003	0.0003	0.0000	0.0000 *
Comp Mole Frac (H2S)	0.0000	0.0010	0.0010	0.0000	0.0000 *
Comp Mole Frac (H2O)	0.1375	0.8277	0.8277	0.1375	0.1375 *
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (EGlycol)	0.8625	0.1710	0.1710	0.8625	0.8625 *
Name	S4				
Comp Mole Frac (Methane)	0.0000				
Comp Mole Frac (Ethane)	0.0000				
Comp Mole Frac (Propane)	0.0000				
Comp Mole Frac (i-Butane)	0.0000				
Comp Mole Frac (n-Butane)	0.0000				
Comp Mole Frac (i-Pentane)	0.0000				
Comp Mole Frac (n-Pentane)	0.0000				
Comp Mole Frac (Benzene)	0.0000				
Comp Mole Frac (p-Xylene)	0.0000				
Comp Mole Frac (Nitrogen)	0.0000				
Comp Mole Frac (Oxygen)	0.0000				
Comp Mole Frac (CO2)	0.0003				
Comp Mole Frac (H2S)	0.0010				
Comp Mole Frac (H2O)	0.8277				
Comp Mole Frac (M-Mercaptan)	0.0000				
Comp Mole Frac (E-Mercaptan)	0.0000				
Comp Mole Frac (nPMercaptan)	0.0000				
Comp Mole Frac (EGlycol)	0.1710				

Energy Streams

Fluid Pkg: All

Name	Q-108	Q-109	Q-106	Q-107	Q-110
Heat Flow (kJ/h)	5.273e+007	1.148e+004	9.170e+007	992.0	3.502e+005
Name	Q-102	Q-104	Q-105	Q-103	Q-101
Heat Flow (kJ/h)	5.819e+007	1.584e+007	3.785e+007	0.0000	7.137e+006

Unit Ops

Operation Name	Operation Type	Feeds	Products	Ignored	Calc Level
Regeneration	Reboiled Absorber	S7 S20 Q-108	S16 S13	No	2500 *
P-100	Pump	S13 Q-109	S14	No	500.0 *
P-101	Pump	S21 Q-107	Sour Water Treatment	No	500.0 *
P-102	Pump	S14 Q-110	Subsea/offshore	No	500.0 *
P-103	Pump	S8 Q-103	S9	No	500.0 *

* Specified by user.

Workbook: Case (Main) (continued)

Unit Ops (continued)

Operation Name	Operation Type	Feeds	Products	Ignored	Calc Level
VLV-100	Valve	From Slug Catcher	S1	No	500.0 *
E-102	Cooler	S16	S17	No	500.0 *
			Q-106		
E-101	Cooler	S6	S7	No	500.0 *
			Q-105		
TEE-100	Tee	S17	S19	No	500.0 *
			S21		
RCY-1	Recycle	S19	S20	No	3500 *
RCY-2	Recycle	S9	S12	No	3500 *
3-Phase Separator	3 Phase Separator	S1	S3	No	500.0 *
			LP Flare		
			S2		
Vacuum Reboiler	Separator	S4	S8	No	500.0 *
		S12	S5		
		Q-102	Q-102		
K-100	Compressor	S5	S6	No	500.0 *
		Q-104			
E-100	Heater	S2	S4	No	500.0 *
		Q-101			

* Specified by user.

LEGENDS
Calgary, Alberta
CANADA

Case Name:	D:\SIMULATION OF MEG (SLIP STREAM RECLAMATION).HSC
Unit Set:	SI
Date/Time:	Fri Jan 04 03:13:27 2013

Workbook: Case (Main)

Material Streams

Fluid Pkg: All

Name		From Slug Catcher	MP Flare	S5	S7	S1
Vapour Fraction		0.0014	1.0000	0.0000	1.0000	0.0016
Temperature	(C)	41.30 *	41.30	85.00 *	126.0	41.30
Pressure	(kPa)	600.0 *	300.0	300.0 *	200.0	300.0 *
Molar Flow	(kgmole/h)	1308 *	2.145	1306	1907	1308
Mass Flow	(kg/h)	3.345e+004	57.89	3.340e+004	3.489e+004	3.345e+004
Liquid Volume Flow	(m3/h)	32.19	0.1204	32.07	34.94	32.19
Heat Flow	(kJ/h)	-4.087e+008	-3.094e+005	-4.031e+008	-4.557e+008	-4.087e+008
Name		S8	S11	Vapor	S4	Salt
Vapour Fraction		0.0000	0.0000	1.0000	0.0000	0.0000
Temperature	(C)	20.00 *	20.00	41.30	41.30	41.30
Pressure	(kPa)	330.0 *	330.0	300.0	300.0	300.0
Molar Flow	(kgmole/h)	1907	762.9	0.0000	1306	0.0000
Mass Flow	(kg/h)	3.489e+004	1.395e+004	0.0000	3.340e+004	0.0000
Liquid Volume Flow	(m3/h)	34.94	13.97	0.0000	32.07	0.0000
Heat Flow	(kJ/h)	-5.451e+008	-2.180e+008	0.0000	-4.084e+008	0.0000
Name		S9	Sour Water Treatmen	S10	S2	S3
Vapour Fraction		0.0000	0.0000	0.0000	0.0000	0.0000
Temperature	(C)	20.00	20.01	20.00 *	41.30	41.30
Pressure	(kPa)	330.0	400.0 *	330.0 *	300.0	300.0
Molar Flow	(kgmole/h)	1144	762.9	1145 *	1306	0.0000
Mass Flow	(kg/h)	2.093e+004	1.395e+004	2.095e+004	3.340e+004	0.0000
Liquid Volume Flow	(m3/h)	20.96	13.97	20.98	32.07	0.0000
Heat Flow	(kJ/h)	-3.271e+008	-2.180e+008	-3.272e+008	-4.084e+008	0.0000
Name		S16	S17	S15	S18	S21
Vapour Fraction		0.0000	0.0000	1.0000	0.0000	0.0000
Temperature	(C)	110.0 *	150.0 *	149.9	150.1	150.1 *
Pressure	(kPa)	145.0 *	20.00	15.00	250.0 *	250.0 *
Molar Flow	(kgmole/h)	108.7	0.0000	108.7	0.0000	0.0000 *
Mass Flow	(kg/h)	3891	0.0000	3891	0.0000	0.0000
Liquid Volume Flow	(m3/h)	3.622	0.0000	3.622	0.0000	0.0000
Heat Flow	(kJ/h)	-3.747e+007	0.0000	-3.194e+007	0.0000	0.0000
Name		S6	S12	S14	Storage Tank.	Storage Tank
Vapour Fraction		0.0000	0.0000	0.0246	0.0000	0.0000
Temperature	(C)	146.8	146.8	139.3	146.8	110.0
Pressure	(kPa)	250.0	250.0	200.0 *	300.0 *	300.0 *
Molar Flow	(kgmole/h)	543.4	434.7	108.7	434.7	108.7
Mass Flow	(kg/h)	1.946e+004	1.557e+004	3891	1.557e+004	3891
Liquid Volume Flow	(m3/h)	18.11	14.49	3.622	14.49	3.622
Heat Flow	(kJ/h)	-1.848e+008	-1.479e+008	-3.697e+007	-1.479e+008	-3.747e+007
Name		S13				
Vapour Fraction		0.0000				
Temperature	(C)	146.8				
Pressure	(kPa)	250.0				
Molar Flow	(kgmole/h)	108.7				
Mass Flow	(kg/h)	3891				
Liquid Volume Flow	(m3/h)	3.622				
Heat Flow	(kJ/h)	-3.697e+007				

* Specified by user.

Workbook: Case (Main) (continued)

Compositions

Fluid Pkg: All

Name	From Slug Catcher	MP Flare	S5	S7	S1
Comp Mole Frac (Methane)	0.0008 *	0.4874	0.0000	0.0000	0.0008
Comp Mole Frac (Ethane)	0.0002 *	0.1153	0.0000	0.0000	0.0002
Comp Mole Frac (Propane)	0.0001 *	0.0327	0.0000	0.0001	0.0001
Comp Mole Frac (i-Butane)	0.0000 *	0.0001	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000 *	0.0002	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000 *	0.0043	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0006 *	0.2219	0.0003	0.0005	0.0006
Comp Mole Frac (H2S)	0.0011 *	0.1158	0.0010	0.0016	0.0011
Comp Mole Frac (H2O)	0.8264 *	0.0222	0.8277	0.9925	0.8264
Comp Mole Frac (M-Mercaptan)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.1707 *	0.0000	0.1710	0.0053	0.1707

Name	S8	S11	Vapor	S4	Salt
Comp Mole Frac (Methane)	0.0000	0.0000	0.4874	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000	0.1152	0.0000	0.0000
Comp Mole Frac (Propane)	0.0001	0.0001	0.0327	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0001	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0002	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0043	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0005	0.0005	0.2219	0.0003	0.0003
Comp Mole Frac (H2S)	0.0016	0.0016	0.1158	0.0010	0.0010
Comp Mole Frac (H2O)	0.9925	0.9925	0.0222	0.8277	0.8277
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.0053	0.0053	0.0000	0.1710	0.1710

Name	S9	Sour Water Treatmen	S10	S2	S3
Comp Mole Frac (Methane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Propane)	0.0001	0.0001	0.0001 *	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (CO2)	0.0005	0.0005	0.0005 *	0.0003	0.0003
Comp Mole Frac (H2S)	0.0016	0.0016	0.0016 *	0.0010	0.0010
Comp Mole Frac (H2O)	0.9925	0.9925	0.9923 *	0.8277	0.8277
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000 *	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.0053	0.0053	0.0054 *	0.1710	0.1710

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name	S16	S17	S15	S18	S21
Comp Mole Frac (Methane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Propane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (CO2)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (H2S)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (H2O)	0.5962	0.0685	0.5962	0.0685	0.0685 *
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (EGlycol)	0.4038	0.9315	0.4038	0.9315	0.9315 *

Name	S6	S12	S14	Storage Tank.	Storage Tank
Comp Mole Frac (Methane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Propane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (i-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Butane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (i-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (n-Pentane)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Benzene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (p-Xylene)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Oxygen)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (CO2)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (H2S)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (H2O)	0.5962	0.5962	0.5962	0.5962	0.5962
Comp Mole Frac (M-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (E-Mercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (nPMercaptan)	0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)	0.4038	0.4038	0.4038	0.4038	0.4038

Name	S13				
Comp Mole Frac (Methane)	0.0000				
Comp Mole Frac (Ethane)	0.0000				
Comp Mole Frac (Propane)	0.0000				
Comp Mole Frac (i-Butane)	0.0000				
Comp Mole Frac (n-Butane)	0.0000				
Comp Mole Frac (i-Pentane)	0.0000				
Comp Mole Frac (n-Pentane)	0.0000				
Comp Mole Frac (Benzene)	0.0000				
Comp Mole Frac (p-Xylene)	0.0000				
Comp Mole Frac (Nitrogen)	0.0000				
Comp Mole Frac (Oxygen)	0.0000				
Comp Mole Frac (CO2)	0.0000				
Comp Mole Frac (H2S)	0.0000				
Comp Mole Frac (H2O)	0.5962				
Comp Mole Frac (M-Mercaptan)	0.0000				
Comp Mole Frac (E-Mercaptan)	0.0000				
Comp Mole Frac (nPMercaptan)	0.0000				
Comp Mole Frac (EGlycol)	0.4038				

* Specified by user.

Workbook: Case (Main) (continued)

Energy Streams

Fluid Pkg: All

Name		Q-101	Q-102	Q-103	Q-107	Q-100
Heat Flow	(kJ/h)	8.972e+007	8.938e+007	1310	5.527e+006	5.290e+006
Name		Q-106	Q-105	Q-108	Q-104	
Heat Flow	(kJ/h)	0.0000	5.027e+006	786.5	1049	

Unit Ops

Operation Name	Operation Type	Feeds	Products	Ignored	Calc Level
Regeneration	Reboiled Absorber	S5 S10 Q-101	S7 S6	No	2500 *
P-101	Pump	S11 Q-103	Sour Water Treatment	No	500.0 *
P-103	Pump	S17 Q-106	S18	No	500.0 *
P-100	Pump	S16 Q-108	Storage Tank	No	500.0 *
P-102	Pump	S12 Q-104	Storage Tank.	No	500.0 *
VLV-100	Valve	From Slug Catcher	S1	No	500.0 *
VLV-101	Valve	S13	S14	No	500.0 *
E-102	Cooler	S7	S8 Q-102	No	500.0 *
E-101	Cooler	S15	S16 Q-107	No	500.0 *
X-100	Simple Solid Separator	S2	Salt Vapor S4	No	500.0 *
TEE-100	Tee	S8	S9 S11	No	500.0 *
TEE-102	Tee	S6	S12 S13	No	500.0 *
RCY-1	Recycle	S9	S10	No	3500 *
RCY-2	Recycle	S18	S21	No	3500 *
V-100	3 Phase Separator	S1	S3 MP Flare S2	No	500.0 *
Vacuum Reboiler	Separator	S21 S14 Q-105	S17 S15 Q-105	No	500.0 *
E-100	Heater	S4 Q-100	S5	No	500.0 *